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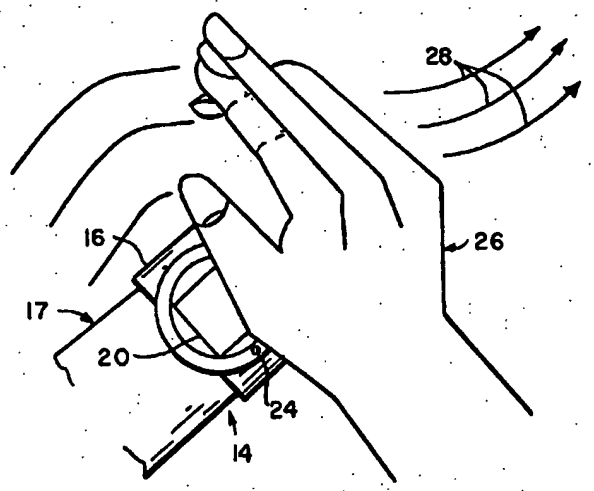

(57) Abstract

Disclosed is an improved user interface for a data processing system, particularly well suited for portable systems configured for donning by a user. A preferred embodiment includes a multifunction wristwatch (14) having a limited display (20) and a single switch (22) for switching between a display state and a data state. Once in the data state, data input, editing and retrieval may be effectuated by deliberate user motion actuation (28) or at least one non-contact sensor (24), for example of the light sensitive or sonic sensitive variety, in accordance with displayed menu options and functions. System logic advantageously may include help messages as well as an edit facility with integral character data sets individually selectable by rotating and non-rotating methods and combinations thereof to facilitate data input.

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NON-CONTACT USER INTERFACE FOR DATA PROCESSING SYSTEM

Technical Field

The present invention relates generally to a user interface for a data processing system and more specifically to a non-contact method and apparatus for interactively selecting system functions and manipulating system data including inputting data into, editing data stored in and retrieving data from a portable data processing system.

Background Information

Portable data processing systems, ranging from costly, highly complex portable computers to relatively inexpensive, simple multifunction timepieces are growing in popularity as users become increasingly accustomed to relying on substantially instantaneous access to a wide variety of stored and contemporaneous data. Typically, the greater the system functionality or the greater the amount or diversity of data stored, the greater the physical size and complexity of the user interface and system overall.

For example, conventional computer hardware and operating systems permit use of a wide variety of application specific software which may facilitate storage and display of data in the form of appointment calendars, addresses, phone numbers or any of a variety of fixed or user defined formats. Additionally, such computers often provide for a limited number of contemporaneous data displays, including current time, day and date. For all the flexibility and functionality of portable computers, however, such systems tend to include cumbersome user interfaces including large displays and full alphanumeric keyboards. Manipulable devices, commonly referred to as

mice, are often provided to reduce the frequency of keyboard use, for example by facilitating selection of software functions and subfunctions in combination with software designed to support such devices. Such mice are of limited use in data entry, however, since actuation of dedicated individual character keys are generally still required to input such data.

Portable computers also tend to be relatively heavy, weighing anywhere from about five pounds to thirty pounds or more and are therefore inappropriate for continuous regular transport and use, especially for routine access to contemporaneous data and limited amounts of stored data. Further, due to relatively high power consumption, such systems typically relay on external power sources requiring proximity to such sources or internal sources such as rechargeable batteries which require regular replacement or replenishment.

Relatively simple, portable data processing systems such as calculators, multifunction timepieces and single purpose dedicated devices, including electronic telephone number directories and the like, provide substantial benefits over computers in terms of lower cost, lighter weight, smaller size and lower power consumption; however, such systems tend to be severely limited both as to the type and quantity of data stored therein as well as the means by which such data is input, edited and retrieved. For example, the user interface of a multifunction timepiece suitable for donning on a user's wrist typically includes a liquid crystal display (LCD) of a sufficient number of characters to display time, day and date alternately or concurrently in alphanumeric format. Additional functions, which may include alarm, timer and the like, are typically selected by manual depression or actuation of one or more of a series of buttons or electromechanical switches disposed proximate the LCD or about the circumference of the timepiece housing. Similarly, resetting of such functions or changing the

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time, day and date typically requires repeated manual depression of one or more of the buttons in a predetermined sequence to access a desired function and incrementally step the contemporaneous or stored data from a currently displayed value to a desired value. In the case of a combination calculator and timepiece, a ten button numeric keypad is routinely provided in addition to separate function keys to select various data processing and display functions and subfunctions.

As is readily apparent, as the number of functions and required number of buttons increases, so too generally does the size of the user interface, as well as the complexity and difficulty of use. Additionally, in the case of a timepiece or other portable data system configured to be routinely worn or carried by a user, it is altogether inappropriate to accommodate a scaled version of a full alphanumeric keyboard thereon due to the excessive resulting size thereof. Decreasing button size and spacing makes actuation difficult for a user and increases the frequency of erroneous actuation. While the technique of nesting multiple characters or functions on a single button by using discrete level shift buttons as a means of shifting between levels within each button tends to reduce the total number of buttons required, such interfaces are cumbersome and altogether inappropriate for general or casual use. The desirability of added functionality is quickly overcome by the inability of a user to reliably actuate the desired function or character in an efficient manner. Further, such interfaces require significant space for labelling or otherwise identifying the multiple characters and/or functions represented by each button. Yet further, each button and associated switch is subject to wear, malfunction and failure and provides an entry path for moisture, dirt and other contaminants which limit the useful life of the interface and system.

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Summary of the Invention

A non-contact user interface apparatus and method is disclosed which is particularly well suited for use with a portable data processing system, the system including conventional elements such as a power source, logic, processing unit, memory and display. The user interface includes a switch for switching the system from a first state, such as a contemporaneous data display state, to a data state. In the data state, any of a variety of functions and subfunctions may be selected by a user from menu type displays, including a help facility for displaying stored help messages. Additionally, data may be input into, edited or retrieved from the system using an edit facility which includes character displays in either a non-rotating or variable scrolling speed rotating format.

Both data manipulation in the edit facility and function selection from the menus is afforded through actuation of at least one non-contact sensor in accordance with deliberate user motions relative thereto. The resultant changes in sensor output are compared with stored waveform images both to ascertain the type of user motion and reject spurious background effects. The non-contact sensor includes a generally conically shaped actuation zone along a line-of-sight thereof. The sensor may be of any suitable type, including those having an output which varies as a function of light intensity, sonic vibration or other suitable parameter sensed along the line-of-sight. A matching parameter source may additionally be provided.

The state switch may be of any of a variety of types, including logical or conventional electromechanical types and may be the same or another non-contact sensor. Where an electromechanical switch is employed, solely the switch may be used by a user to interface with the system in the event ambient conditions are unsuitable for operation with the non-contact sensor, or otherwise as desired as an optional interface method.

The compact, non-contact user interface with menu display and help messages affords the capability of

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providing heretofore unknown ease of use and diversity of functionality and data storage and manipulation in a portable data processing system suitable for donning by a user. The user interface is substantially free from the reliability and contamination problems of the type which plague conventional interfaces having numerous contact type switches.

Brief Description of Drawings

The novel features believed characteristic of the invention are set forth and differentiated in the appended claims. The invention in accordance with preferred and exemplary embodiments, together with further advantages thereof, is more particularly described in the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a schematic, plan view of a portable data processing system incorporating a non-contact user interface in accordance with a preferred embodiment of the present invention;

FIG. 1A is a schematic, perspective view of one method of actuation of the user interface depicted in FIG. 1 in accordance with an exemplary embodiment of the present invention;

FIG. 1B is a schematic, plan view of a portable data processing system incorporating a non-contact user interface in accordance with an alternate embodiment of the present invention;

FIG. 1C is a schematic, obverse plan view and a schematic, reverse plan view of another portable data processing system incorporating a non-contact user

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interface in accordance with another alternate embodiment of the present invention;

FIG. 2 is an enlarged, schematic perspective view of exemplary actuation zones of the user interface depicted in FIG. 1 in accordance with a preferred embodiment of the present invention;

FIG. 3 is an enlarged, schematic perspective view of multiple exemplary actuation zones of the user interface depicted in FIG. 1B in accordance with an alternate embodiment of the present invention;

FIG. 4 is an enlarged, schematic sectional view of a non-contact sensor of a user interface in accordance with a preferred embodiment of the present invention;

FIG. 5 is an enlarged, schematic sectional view of a non-contact sensor including a sensor in combination with a compatible source in accordance with an alternate embodiment of the present invention;

FIG. 5A is an enlarged, schematic sectional view of an alternate non-contact sensor including a sonic detector in combination with a compatible sonic source in accordance with another alternate embodiment of the present invention;

FIG. 6 is a schematic, generic block diagram of a portion of the portable data processing system depicted in FIG. 1 in accordance with a preferred embodiment of the present invention;

FIGS. 6A, 6B and 6C are schematic, simplified partial block diagrams of three alternate data processing systems of the type depicted in FIG. 6 for use with various alternate non-contact sensor configurations in accordance with alternate embodiments of the present invention;

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FIG. 7 is a schematic, graphical illustration of various exemplary rotating selection and non-rotating selection methods of inputting numeric data in accordance with a preferred embodiment of the present invention;

FIG. 7A is a schematic, graphical illustration of various exemplary rotating selection and non-rotating selection methods of inputting alphabetic data in accordance with a preferred embodiment of the present invention;

FIG. 7B is a schematic, graphical illustration of various exemplary rotating selection and non-rotating selection methods of retrieving data in accordance with a preferred embodiment of the present invention;

FIG. 7C is a schematic, graphical illustration of various exemplary methods of setting variable scroll speed and scroll direction of the rotating selection method illustrated in FIGS. 7A and 7B in accordance with a preferred embodiment of the present invention;

FIG. 7D is a schematic, graphical illustration of an exemplary method of directly controlling scroll speed and direction in accordance with a preferred embodiment of the present invention;

FIG. 8 is a schematic, graphical illustration of non-contact sensor output during a single step exemplary actuation sequence in accordance with a preferred embodiment of the present invention;

FIG. 9 is a schematic, graphical illustration of non-contact sensor output during a multiple step exemplary actuation sequence in accordance with a preferred embodiment of the present invention;

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FIGS. 10, 10A and 10B set forth a schematic, block diagram flow chart of sensor output waveform analysis in accordance with a preferred embodiment of the present invention;

FIG. 11 is a schematic, graphical illustration of system circuitry in accordance with a preferred embodiment of the present invention; and

FIG. 12 is a schematic, graphical illustration of a multiple step exemplary actuation sequence in accordance with an alternate embodiment of the present invention.

Mode(s) for Carrying Out the Invention

Referring now to the drawings in more detail, depicted in FIG. 1 is a schematic, plan view of a portable data processing system 10 incorporating a non-contact user interface, shown generally at 12, in accordance with a preferred embodiment of the present invention. More specifically, system 10 is configured as a multifunction timepiece or wristwatch 14 and includes a strap 16 suitable for donning about a wrist 17 of a user, as shown in FIG. 1A. Wristwatch 14 includes a housing 18 in which are packaged conventional elements (not depicted) of such a system 10, including a battery or other source of power for operating the system 10, a processing unit and associated logic for controlling the operation of the system 10, memory for storage of logic and data, and a display 20, shown here as a five row LCD suitable for displaying stored and contemporaneous data, such as the current time, to a user.

User interface 12 further includes a contact actuated switch 22, disposed at any suitable location, such as along the perimeter of the housing 18, and at least one non-contact sensor 24, preferably disposed proximate the display 20. Switch 22 may be used to switch the system 10

from a first state, such as a contemporaneous data display state for displaying current time in hours, minutes and seconds, as shown, to a data state in which a user may select from a menu of functions or displays, as will be discussed in greater detail hereinbelow. At least when in the data state, however, system 10 is responsive to deliberate actions by a user, for example, passage of a user's hand 26 across the display 20 and consequently across the sensor 24 generally along arrows 28 as depicted in FIG 1A. Such actions typically may occur in response to a system prompt or message on display 20 and are recognizable as such by analysis of time varying output of sensor 24 according to system logic. In this manner, a user may advantageously actuate the sensor 24 and interface with the system 10 while the system 10 is in the data state without having to depress a button or otherwise physically contact any portion of the interface 12 or system 10. As will become readily apparent, by providing sufficiently sophisticated waveform tracking circuitry and waveform analysis logic, the system 10 may readily distinguish the duration, frequency and other relevant parameters pertaining to user motion such that interface 12 can be used to rapidly and efficiently enter, change and retrieve data and permit selection from any of a variety of contemporaneous or stored data displays.

Shown in FIG. 1B is a schematic, plan view of a portable data processing system 110 incorporating a non-contact user interface 112 substantially similar to that depicted in FIG. 1; however, instead of a single sensor 24, user interface 112 includes four non-contact sensors 124a, 124b, 124c and 124d generally equiangularly spaced about display 120. Multiple sensors 124 may be employed for a variety of functionally advantageous purposes, in addition to providing redundancy. For example, two or more sensors 124 may be used in combination with suitable system logic to provide means for determining directionality of actuation motion. Directionality of motion may be used by

the system 10 as an indication of user intent to change system states from a first display state to a data state, for example, thereby obviating the need for switch 122 to perform this function, if desired. Alternately or additionally, overlap of respective actuation zones of individual sensors 124 at a fixed distance above the display 120, as will be discussed in more detail with respect to FIG. 3 hereinbelow, affords the means to reject common actuation motions and sensed background changes. In other words, each sensor 124 may be used as a relational reference to all other sensors 124 such that only user motions proximate the display 120 or individual sensors 124 will be recognized as deliberate actuation motions and acted upon. By using multiple sensors 124, many levels of system functionality may be added at relatively low cost.

FIG. 1C depicts yet another alternate embodiment of the present invention. Shown is a schematic, obverse plan view and a schematic, reverse plan view of portable data processing system 210 incorporating a non-contact user interface 212 substantially similar to that depicted in FIG. 1B; however system 210 is configured to be held in a user's hand or suspended from a user's neck or apparel by a tether or other suitable apparatus (not depicted). User interface 212 includes four non-contact sensors 224a, 224b, 224c and 224d generally symmetrically disposed in a diamond pattern proximate display 220 and two switches 222a and 222b also symmetrically disposed proximate the display 220 along a perimeter of the interface 212 to facilitate actuation by a user when the system 210 is cradled in a user's hand. Yet further, a plurality of additional switches, shown generally at 222n (ten depicted of which two are delineated), may be included and symmetrically disposed flush with or in recesses formed in the reverse of the system 210 to prevent inadvertent actuation thereof. Use of more than one switch 222 may be desirable, for example, to provide alternate means of selecting system functions or manipulating data in addition to that afforded

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by the non-contact sensors 224 in accordance with the teachings disclosed herein; however, as discussed hereinabove, the switches 222 may be eliminated altogether with the function of switching between a first state and the data state afforded solely by one or more non-contact sensors 224 in combination with system logic. The size, quantity and location of the display 220, switches 222 and non-contact sensors 224 as well as the overall configuration of the interface 212 and system 210 may be designated to accommodate needs of a particular user and the depictions of FIGS 1, 1B and 1C are representative of preferred and alternate embodiments contemplated for general or casual use; however, such depictions are not considered to be limiting but rather merely representative of the underlying concept disclosed herein.

Looking now to FIG. 2, shown is an enlarged, schematic perspective view of exemplary conical actuation zones, shown generally at 30, of non-contact sensor 24 depicted in FIG. 1 in accordance with a preferred embodiment of the present invention. Location of the sensor 24 has been rotated ninety degrees in the plane of the housing 18 to facilitate depiction herein. Sensor 24 includes a series of inverted, generally frustoconical actuation zones 30 disposed substantially symmetrically along a line-of-sight 32 thereof. Line-of-sight 32 is depicted here as coincident with axis Z of mutually orthogonal axes X, Y and Z having their respective origins at the intersection of the sensor line-of-sight 32 with the plane of sensor 24. The plane of sensor 24, which includes the common XYZ origin, is designated Zone 0. Serially disposed axially outwardly therefrom along the line-of-sight 32 are Zone 1, Zone 2 and Zone 3, respectively. As is readily apparent, cross-sectional areas of actuation zones 30 increase as distance from the plane of the sensor 24 increases. The size, orientation and configuration of the conical zones 30 are a function both of the particular characteristics of the non-contact sensor 24 employed as well as the method of

mounting the sensor 24 in the housing, as will be explained in further detail beginning with FIG. 4.

When multiple noncontact sensors 124 are employed, for example similar to the configuration of the user interface 112 depicted in FIG. 1B, respective conical actuation zones 130 may advantageously overlap at a given distance above the plane of the sensors 124, as shown generally in FIG. 3, but for the truncation of respective zones 130 herein. To facilitate depiction, sensor 124b is shown solely with respective Zone 0 of actuation zone 130b, sensors 124a and 124c are shown solely with Zone 0 and Zone 1 of respective actuation zones 130a and 130c, and sensor 124d is shown with Zone 0, Zone 1 and Zone 2 of respective actuation zone 130d. It should be noted, however, that all sensors 124 may include full actuation zones extending from Zone 0 through Zone 2 and beyond.

Since the useful range of a typical sensor 124 is limited, the axial extent or distance of active zones along the line-of-sight 132 of a particular sensor 124 may be electronically selected to achieve a desired result. For example, with respect to user interface 112, solely the zones depicted of respective sensors 124 may be active; therefore any deliberate user motion other than at Zone 0 would not actuate sensor 124b. Similarly, deliberate user motions beyond Zone 1 of either sensor 124a or 124c would not actuate sensors 124a, 124c; however, a deliberate user motion passing through Zone 2 would actuate sensor 124d, solely. Accordingly, system logic may be advantageously configured to respond to deliberate user motions of a given type which pass through a particular zone of a particular sensor 124 or group of sensors 124. As will be discussed in further detail hereinbelow, system 110 thereby has the capability of differentiating between a Zone 0 hand clasp, which covers all sensors 124 at close proximity thereto, and a single motion hand wave which generally passes through Zone 2.

The number and axial geometric extent of respective zones may be selected by system logic in combination with sensor sensitivity and associated circuit component tolerances. Beyond a predetermined axial distance, the sensor 124 may be considered inactive. For example, deliberate user motions passing through Zone 3 or beyond may be rejected, not actuating the sensor 124. For this configuration, ambient environmental changes occurring in Zone 3 and beyond will similarly be rejected. Since sensor zone designation may be controlled by system logic, the user interface 112 may be configured to accommodate the requirements of a particular application generally, or be specifically configured to suit differing requirements of designated functions and subfunctions within a particular system 110.

In the case where all sensors 124 are active through and including Zone 2, a broad, sweeping motion of a user's hand 26 similar to that depicted in FIG. 1A will tend to actuate all sensors 124 if the motion passes at a height above the interface 112 corresponding to Zone 2; whereas more precise motions, such as that of a finger of a user which passes proximate the interface 112, for example through Zone 1 of solely sensor 124a, will tend to actuate solely sensor 124a to the exclusion of the remaining sensors 124b, 124c and 124d.

As stated hereinabove, multiple sensors 124 may be used in combination with supporting logic for purposes of redundancy, determining directionality or sequence of sensor actuation, rejecting common actuation motions or adjusting to uniform changes in ambient. For example, sensors 124 which vary their output as a function of light sensed generally along a line-of-sight 132 thereof may be used in pairs or greater quantities as relational references, one to another, to reject changes in ambient light commonly sensed. Solely deliberate user motions may be advantageously recognized and acted upon and spurious or environmental effects may be readily rejected.

FIG. 4 is an enlarged, schematic sectional view of a typical non-contact sensor 24, such as that depicted in FIG. 1, mounted in housing 18. Sensor 24 includes one or more electrical leads 34 generally for providing power to and conveying output from the sensor 24. In order to limit and shape the actuation zone 30 thereof, the sensor 24 may be advantageously disposed in a suitably configured recess 36 which also acts to protect the sensor 24 from impact with foreign objects which could damage the sensor 24 or otherwise impair performance or output of the sensor 24. For example, for a sensor 24 with a generally convex outer surface 38 which varies output as a function of light sensed generally along a line-of-sight 32 thereof, a recess 36 having a circular cross-section will provide an actuation zone 30 of substantially conical shape, similar to that depicted in FIG. 2. By modifying the convexity of outer surface 38 and/or the depth of the recess 36 in which the sensor is disposed, the actuation zone 30 may be varied between a narrowly diverging cone to a more widely diverging cone. Further, the recess 36 may be configured to accommodate disposal therein of an element 40 such as a lens or filter. In the case where sensor 24 is a light sensitive sensor, a lens 40 may be employed to further modify the shape of the actuation zone 30 as well as provide additional protection to the sensor 24. Additionally or alternatively, a filter 40 of fixed characteristics or of the type which automatically, passively varies light transmissibility as a function of light intensity, for example, may be employed to further protect the sensor 24 by preventing saturation thereof in excessively intense ambient light settings such as bright, direct sunlight.

Use of such a variable filter 40 also obviates or reduces the complexity of sensitivity and automatic gain control circuitry 68, as well as power requirements associated therewith, as discussed with respect to FIG. 6 hereinbelow. A variable filter 40 facilitates operation of

the system 10 and interface 12 whenever there exists at least sufficient ambient light for a user to discern the display 20.

Clearly, a light sensitive sensor 24 may be readily employed alone where there exists sufficient ambient light to permit system logic to reliably recognize sensor output changes resulting from predetermined user motion. For example, when the interface 12 is used outdoors, a user passing a hand 26 through actuation zone 30 will cause a generally greater change in sensor output on a sunny day than on an overcast, cloudy day when ambient light is generally at a lower average intensity. In order to provide for reliable actuation of the sensor 24 irrespective of ambient light conditions, user interface 12 may be configured with a sensor 24 in combination with a suitable source 42 as depicted in FIG. 5. In the case of a light sensitive sensor 24, source 42 may be a light source of predetermined or automatically variable intensity having one or more electrical leads 134 providing power thereto. Source 42 may be an incandescent source or preferably a low power consumption light emitting diode (LED), for example, and is advantageously mounted proximate sensor 24 in common recess 136 of housing 118. Alternatively, the source 42 may be remotely located with light transmitted proximate the sensor 24 by fiber optic cable or bundle (not depicted). A shield 44 may be disposed between the sensor 24 and source 42 to prevent inadvertent sensor actuation. Source 42 may be oriented to provide output which generally intersects with the sensor line-of-sight 32 within a desired height range, for example Zone 1, if user actuation motion is desired proximate the housing 18. A lens or other element 40 may be provided to focus the source 42, if desired.

As may be readily understood, passage of a user's hand proximate the source causes a light beam to be displayed thereon generally along the line-of-sight 32 of the sensor. System logic is capable of recognizing deliberate actuation

both due to a temporary diminution in sensor output, as would be the case in a bright ambient light condition without the source 42 energized, as well as a temporary enhancement in sensor output, as would be the case in a dim ambient light condition in combination with the energized source 42. Beyond facilitating sensor actuation irrespective of ambient lighting conditions, source 42 provides a means by which a user may readily ascertain the location of the sensor 24 in low light conditions, such as outdoors during the evening or in a dimly lit room.

System logic may be sufficiently sophisticated to automatically configure the system 10, depending on ambient light conditions. For example, when in dark ambient settings, sensor 24 may be employed as a light/dark detector initially, as when the system 10 first enters the data state due to actuation of switch 22 by a user. If there exists insufficient ambient light to reliable actuate the sensor 24, source 42 may be energized automatically. Alternately or additionally, system logic may be configured such that a rapid repeat actuation of the switch 22 disables the sensor 24 and source 42 altogether, with user interface 12 operated thereafter solely by means of actuation of switch 22. Such an option is contemplated to be desirable when the system 10 is used in radical or extreme ambient environments, which may occur from time to time.

Instead of employing a sensor 24 sensitive to light, the user interface 12 may rely on a non-contact sensor 24 which varies output as a function of sonic vibrations. FIG. 5A depicts a sonic sensor 46 which includes an ultrasonic detector in combination with a compatible ultrasonic source disposed in housing 218. As with the light sensitive sensor 24, sonic sensor 46 may be used singly or in combination with other sonic sensors 46 or light sensitive sensors 24 in the various preferred and exemplary system embodiments depicted or contemplated herein. Sonic sensor 46 includes electrical leads 234

generally for providing power to and conveying output from the sensor 46. In order to advantageously shape the actuation zone 30 thereof, the sensor 46 may be disposed in a suitably configured recess 236 which also acts to protect the sensor 46 from impact with foreign objects which could damage the sensor 46 or otherwise impair performance or output thereof.

As depicted here, recess 236 includes a generally cylindrical first portion 236a proximate the sensor 46 and a generally outwardly diverging, frustoconically shaped second portion 236b exposed to ambient. Therebetween is disposed a protective element 140. As with the shape of recess 36 of FIG. 4, the shape of recess 236 may be adapted to modify the shape of the sensor actuation zone 30 resulting therefrom. In the case of a sonic sensor 46 which includes both an ultrasonic detector and source, the conically shaped second portion 236b is preferred to provide dispersal of the emitted ultrasonic energy and focusing of the reflected ultrasonic energy. Protective element 140 is preferably a fine screen mesh to prevent inadvertent contact of the sensor 46 with foreign objects while readily permitting sonic energy transmission therethrough. Additionally, the element 140 may be chemically waterproofed and/or dustproofed to minimize the influx of moisture and/or clogging thereof by airborne contaminants or particulate matter which could impair sensor performance. Further, a light source 142 may be provided, being disposed in the housing 218 proximate the recess 236, to provide a means by which a user may readily ascertain the location of the sensor 46, especially in low ambient light conditions. Light source 142 may be any suitable device, for example, an LED powered through electrical leads 334.

Referring now to FIG. 6, depicted is a schematic, generic block diagram 48 of a portion of system 10 in accordance with a preferred embodiment of the present invention. A processing unit block 50, corresponding to a

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microprocessor, microcontroller or other typical data processing device includes conventional elements or functions such as a counter or timer 52, a clock circuit 54, read only memory (ROM) 56 in which system logic is advantageously stored, and random access memory (RAM) 58 suitable for storage of user input and accessible data, as well as temporary storage of conditioned sensor output tracking information 80. Processing unit 50 further includes a control bus, shown generally at 60, which connects the processing unit 50 with the remainder of system circuitry and over which communications occur. These communications typically include one or more each of signals such as power, control, interrupt 61 and tracking information 80. The interrupt signal 61 may be advantageously employed to activate one or more of the various processing unit functions when a deliberate user motion is to be detected, as will be discussed in greater detail hereinbelow.

Disposed between the sensor block 62, which may include a non-contact sensor 24, 46, optional source 42 and associated dedicated circuitry, and the processing unit block 50 is a motion detection circuit block, shown generally at 64. Motion detection circuit block 64 may include a digital signal processor or other circuitry adapted to condition sensor output signal 66 for advantageous use by the processing unit 50. This circuitry 64 includes a sensitivity and automatic gain control (AGC) block 68, a detection circuit block 70, which may include means for automatically switching between higher ambient light daytime operation and lower ambient light nighttime operation, and a waveform tracking circuit block 72. Motion detection circuit power and sensor/source power may be provided, as depicted, through switch 76 from a suitable power source such as a system battery (not depicted) and waveform tracking circuit power may be provided through a separate switch 74. Switch 76 may be advantageously closed only when detection is required so as to reduce power

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consumption during periods when the sensor block 62 and motion detection circuit block 64 need not be energized, for example, during operation of the system 10 solely in a contemporaneous data display state. Switch 76 may be closed, either logically, mechanically or otherwise, when in the data state when it is desirable to use the sensor 24, 46 and associated circuitry 64 to detect deliberate user motions. Further, switch 74 may be closed solely upon detection of a predetermined change in sensor output 66 to further reduce overall system power requirements.

FIGS. 6A, 6B and 6C are schematic, simplified partial block diagrams of three alternate data processing systems 48a, 48b and 48c, respectively, of the type depicted in FIG. 6 for use with various alternate non-contact sensor configurations in accordance with alternate embodiments of the present invention. Looking first to FIG. 6A, depicted therein is a partial system block diagram 48a of a system configured for use in ambient light conditions, such as system 10 shown in FIG. 1. System block diagram 48a includes a processing unit 50a, a sensor block 62a corresponding to a non-contact sensor 24 of the ambient light sensitive variety, a compatible ambient light sensitive motion detection circuit 70a and a motion detection circuit power switch 76a. Switch 76a provides power to both sensor block 62a and detection circuit 70a when desired. Processing unit block 50a receives an interrupt signal 61a upon occurrence of a predetermined change in sensor output signal 66a in accordance with a deliberate user motion.

FIG. 6B depicts a partial system block diagram 48b of a system configured to detect deliberate user motions irrespective of ambient light conditions. System block diagram 48b includes a processing unit 50b, a sensor block 62b corresponding to a non-contact sensor 24 of the light sensitive variety in combination with a suitable light source 42 as depicted in FIG. 5, a compatible reflective light sensitive motion detection circuit 70b and a motion

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detection circuit power switch 76b. Switch 76b provides power to both sensor block 62b and detection circuit 70b when desired. Processing unit block 50b receives an interrupt signal 61b upon occurrence of a predetermined change in sensor output signal 66b in accordance with a deliberate user motion. Light source 42 may be energized whenever switch 76b is closed or preferably may be partially or fully energized as a function of ambient light conditions sensed by circuit 70b through sensor output signal 66b. Modulation of source power signal 78 may be employed to further reduce overall system power consumption.

Lastly, FIG. 6C depicts a partial system block diagram 48c of a system configured to detect deliberate user motions based on sonic detection of proximate user motions. System block diagram 48c includes a processing unit 50c, a sensor block 62c corresponding to a non-contact sonic sensor 46, such as an ultrasonic detector in combination with an ultrasonic source as depicted in FIG. 5A, a compatible sonic motion detection circuit 70c and a motion detection circuit power switch 76c. Switch 76c provides power to both sensor block 62c and detection circuit 70c when desired. Processing unit block 50c receives an interrupt signal 61c upon occurrence of a predetermined change in sensor output signal 66c in accordance with a deliberate user motion.

Before describing particulars concerning sensor output waveform analysis and tracking and associated circuitry for such purposes, it is desirable to first present preferred and exemplary embodiments of system logic as presented to a typical user. With reference to FIG. 1, when a user desires to input data into system 10, for example to change the time displayed by a contemporaneous data display subfunction called "TIME", the user switches the system 10 from the depicted time display state to the data state by means of manual actuation of switch 22. Once in the data state, user selects the "TIME" subfunction and a data edit

facility thereof, as will hereinafter be described with respect to FIG. 7B. Once in the edit facility, system logic provides an opportunity for the user to select and input numeric data by one or more of a variety of methods.

FIG. 7 is a schematic, graphical illustration of various exemplary rotating selection and non-rotating selection methods of inputting numeric data in accordance with a preferred embodiment of the present invention. Depending on the size and configuration of the display 20 of a particular user interface 12, as well as the size of the character data set, one of the following types of selection methods may be more advantageous than another. For example, first presented in FIG. 7 is a horizontal rotation display 20a of a rotating selection method particularly suited for applications of relatively small display size where one row of numeric characters is displayed, depicted here as ten characters across, comprising "1" through "9" and "0". Once within the edit facility, the numeric character row is displayed and a pointer, cursor or other indicia is provided which automatically rotates sequentially from a first numeric character to the next numeric character and so on. When the pointer indicates a desired numeric character sought to be input by the user, a deliberate user motion proximate the sensor 24, such as a single wave of the user's hand 26, is recognized by the system 10 as a single motion interrupt and the numeric character is thereby selected. Shown in FIG. 7, for example, is the selection of the numeric character "7". If the user fails to select a numeric character when the pointer has reached "0" at the end of the row, the pointer simply wraps around and begins the rotation once again at "1". Both scrolling direction, that is the direction of travel of the pointer on the display 20a, and scrolling speed, that is the speed at which the pointer sequences from one character to the next, may be fixed or preferably may be variable, being selectable by a user as will be described in further detail hereinbelow

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with respect to FIG. 7C. Further, display 20a may be limited in size such that solely nine or fewer numeric characters are presented to the user at any given time. In other words, instead of the pointer scrolling across fixed position numeric characters, the numeric characters may scroll sequentially relative to a fixed pointer location, or some combination thereof.

Instead of a single row, horizontal rotation display 20a, a user interface 12 may be advantageously configured with a multiple row, vertical rotation display 20b, such as that depicted also in FIG. 7. Display 20b includes the same ten numeric characters of display 20a; however, the characters are arranged in two rows of five characters or columns each. Here, the pointer rotates vertically, that is to say alternately between the first row and the second row. In order for the user to select "7", for example, when the pointer indicates the row comprised of numeric characters "6" through "0", a deliberate user motion proximate the sensor 24, such as a double wave of the user's hand 26 or more simply a two finger wave, is recognized by the system 10 as a double motion interrupt and the numeric character in the second column of the row is thereby selected, the numeric character "7". To prevent inadvertent selection of characters, for example where the user employs multiple successive hand waves instead of a closely coupled multiple finger wave, a timeout feature is advantageously provided whereby the numeric character is recognized by the system 10 as being selected by the user after an appropriate time delay after initial interruption, for example one second. As with the horizontal rotation display 20a, not all of the characters of a given row need be displayed simultaneously, for example, where the display 20b is limited in size such that solely four or fewer numeric characters are presented to the user at any given time. Further, scrolling speed and direction may be fixed or preferably may be variable, especially in the case where the display 20b includes more than two rows.

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Lastly, FIG. 7 depicts a non-rotating selection method for selecting numeric data. Non-rotating display 20c, as depicted here, includes a single row of ten numeric characters plus a null zone at which location the pointer starts. In order to select "7", a user would provide seven discrete deliberate motions recognizable by the system in any of the manners heretofore discussed. As depicted, the user executes a three finger wave to advance the pointer from the null zone to "3", followed by a four finger wave to advance the pointer to "7", the desired character. After an appropriate timeout, the character "7" is recognized by the system 10 as the desired input character and entered as data. The pointer then returns to the null zone.

As may be readily appreciated, any of a variety of combinations of non-rotating and vertical and horizontal rotating data selection methods may be employed to advantage depending on a particular application, especially where the data sets are larger, and all such methods are considered within the scope of this invention. Instead of a selectable data set comprised of merely ten numeric characters, for example, FIG. 7A depicts a schematic, graphical illustration of various exemplary rotating selection and non-rotating selection methods and combinations thereof for inputting alphabetic data in accordance with a preferred embodiment of the present invention. Display 20d exemplifies a vertical then horizontal rotating selection method, whereby twenty-six alphabetic characters plus four additional, optional commands are displayed in six rows of five columns each. Any desired ordering may be provided, as here where vowels are included in the first row. For example, a QWERTY keyboard or other desired display configuration may be adopted if deemed advantageous for a particular application.

Once the data set or a portion thereof is displayed, the pointer sequentially rotates vertically by rows until a

single hand wave indicates a desired row selection. Then a horizontal pointer rotation by column within the selected row ensues until a subsequent single hand wave indicates a desired character within that row has been selected. In the particular example depicted, a user selects the character "C" from display 20d by a single hand wave when the pointer rotates to the second row followed by a single hand wave when the pointer rotates to the second column thereof.

Display 20e exemplifies a vertical rotating then non-rotating selection method for similarly selecting character "C". When the vertically rotating pointer indicates the second row, a two finger wave advances the pointer horizontally to the second column to select the desired character. Alternately, two consecutive hand waves could be employed once the pointer indicates the second row to achieve a similar result.

Lastly, FIG. 7A depicts a non-rotating selection method for a multiple column, multiple row data set, such as the alphabetic character data set of display 20d, display 20f depicting solely a portion thereof. Display 20f includes a null zone comprising an entire row in advance of the first row of alphabetic character data, here vowels "A", "E", "I", "O", and "U". Two consecutive hand waves or more simply a two finger wave advances the pointer to the second row. After an appropriate timeout period, such as one second, a two finger wave or two consecutive hand waves advances the pointer to the second column to select character "C".

Commands such as "DELETE", depicted for example on display 20d, may be selected by the appropriate method for selecting any other character of the respective display 20 or alternately, system logic may provide for automatic execution of such commands by other methods. For example, covering an ambient light sensitive sensor 24 with a hand clasp for a first predetermined period, such as about one and one-half seconds, while the system 10 is in the data

edit facility may be recognized by the system 10 as a command to delete the last entered character. Similarly, covering sensor 24 for a longer predetermined period, such as about three seconds, may be recognized by the system 10 as a command to exit the data edit facility or alternatively as a command to exit the data state altogether and return to a previous contemporaneous data display state, such as the display of current time. An audible sound such as a beep, series of beeps or other indication may be provided the user at the one and one-half and three second periods to alert the user as to the status of the system 10.

In addition to entering and editing data with numeric and alphabetic character data sets according to rotating and non-rotating selection methods and variants thereof, system logic may be advantageously configured to facilitate selection of system functions and subfunctions from a main menu in the data state, as well as accommodate retrieval of stored data. For example, once the data state is entered, a main menu may be displayed of a plurality of submenus or functions, including one or more stored data display subfunctions for displaying stored data and one or more variable contemporaneous data display subfunctions for displaying contemporaneous data. FIG. 7B is a schematic, graphical illustration of various exemplary rotating selection and non-rotating selection methods of retrieving data in accordance with a preferred embodiment of the present invention.

Display 20g exemplifies a rotating selection method for selecting one of three submenus from the three line main menu display depicted therein. Clearly, any number of submenus may be provided as a particular application warrants. When the rotating pointer indicates the desired submenu, a deliberate hand wave by the user selects the then designated submenu. In the example depicted, a single hand wave employed when the pointer is at the second line selects the submenu designated herein as "MENU #2", which

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might include therein a plurality of system functions and subfunctions including, for example, the contemporaneous data display subfunction called "TIME" and the associated data edit facility discussed hereinabove for setting the time displayed. Display 20h, also shown in FIG. 7B, depicts selection of the same submenu, "MENU #2", from the main menu display by means of a non-rotating selection method. The pointer is advanced two lines from a null zone by a two finger wave, with selection of the submenu accomplished upon elapse of a one second timeout period.

While selected "MENU #2" might designate contemporaneous data display subfunction "TIME", it could alternately designate a stored data display subfunction called "PEOPLE". "PEOPLE" may include, for example, a plurality of separate data files in a data bank, each file comprising an individual's name, address and telephone number or any other identifying information sought to be stored for later retrieval. Such a data bank display 20i is depicted in FIG. 7C, wherein respective data files are designated "DATA 1", "DATA 2"..."DATA n". Clearly where more than a few files are created, for example in the case where "n" equals 50, it is desirable to provide for the capability to vary scrolling speed as well as direction when a rotating selection method is employed, especially where a display 20 may include five or fewer rows or lines, as depicted in FIG. 1.

Returning to FIG. 7C, upon selection of "PEOPLE", by default, the first few files are displayed with the pointer at "DATA 1", scroll speed is set at zero and direction is set forward. A two finger wave correlates with a scroll speed of two data files per second, for example. A subsequent single wave, such as the hand wave depicted, resets the scroll speed to zero at the file presently indicated by the pointer, in this case at "DATA 23". Where another file is sought, a subsequent wave, such as the four finger wave depicted here, resumes forward scrolling at the rate of four data files per second. Momentarily covering

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an ambient light sensitive sensor 24 with a finger, as depicted next, is recognized by system logic as indicative of a user's desire to change scrolling direction, at a default speed of one file per second. Lastly, another single wave, such as the hand wave depicted, stops scrolling now at "DATA 26", the desired stored data file. Covering the sensor 24 with the depicted hand clasp for a first predetermined period, for example up to one and one-half seconds, selects the "DATA 26" file for display and edit with an associated edit facility as described hereinabove. Retaining the hand clasp for a total predetermined period between about one and one-half seconds and three seconds executes an escape and retaining the hand clasp for a total predetermined period greater than about three seconds exits the data bank altogether. An audible sound such as a beep, series of beeps or other indication may be provided at the one and one-half and three second periods to alert the user as to the status of the system 10.

While the "DATA 26" file selected may contain a relatively small amount of data therein, such as the name, address and telephone number information discussed hereinabove, "DATA 26" might contain much more data, for example, a series of alphanumeric lines, sentences, or paragraphs or even more extensive data in tabular or other form. A particularly useful file may include one or more of a series of help messages. Such help messages may be provided to inform a user as to the proper method of operation of the system 10, as well as to provide more detailed information regarding system functions and subfunctions. Alternately or additionally, such help messages may be provided to inform a technician of relevant system diagnostic procedures and detailed information related thereto.

FIG. 7D is a schematic, graphical illustration of an exemplary method of directly controlling scroll speed and direction which may be especially advantageous with respect

to more extensive data storage in larger data files such as "DATA 26". For example, depending on system logic, once a particular message unit, such as line, sentence or paragraph is selected, as shown in display 20j, deliberate user motions such as a multiple finger wave or repeated multiple finger waves may be employed to set scrolling speed within the message unit. Display 20j depicts fanning with four fingers to yield multiples thereof of scrolling speed in characters per second. Scrolling speeds of up to about thirty characters per second or greater are achievable if desired; however at the higher speeds, user comprehension and retention may tend to diminish. Selection of a particular message unit may be achieved by any selection method discussed hereinabove. Further, variable scrolling speed and direction regarding the selection method employed are also selected in a similar manner to that disclosed with respect to FIG. 7C. Similar selection, escape and exit timeout features may be advantageously provided.

Having discussed the particular preferred and exemplary embodiments of system operating logic, attention may now be turned to discussion of the method by which system 10 recognizes a deliberate user motion. FIG. 8 is a schematic, graphical illustration of non-contact sensor output voltage as a function of time during a single motion hand wave in accordance with a preferred embodiment of the present invention. Here, the sensor 24 is of the ambient light sensitive variety, a decrease in voltage corresponding to a decrease in ambient light sensed along a line-of-sight 32 thereof due to passage of a user's hand 26 therethrough.

Analysis of the output waveform may best be described as a series of ten discrete steps, designated in FIG. 8 by means of circled numbers one through ten. Given that the sensor 24 is energized (i.e. switch 76 is closed) and providing a substantially constant output voltage V_o, upon diminution of output voltage a predetermined relative or

absolute amount from V_o at time T_1, a motion interrupt is thereby detected. The interrupt signal 61 is transmitted to the processing unit 50 resulting in the waveform tracking circuit 72 being energized by closure of switch 74 and the timer 52 being initiated. Additionally, the present sensor output voltage is stored. Thereafter, sensor output voltage level is measured as a function of time and temporarily stored in RAM 58 to permit calculation of instantaneous fall time slopes and facilitate determination of the lowest output voltage, V_L, at time T_2. Fall time may then be determined as the period between T_2 and T_1. Instantaneous rise time slopes are then calculated by measurement and storage of increasing output voltage as a function of time until a predetermined output voltage is attained at time T_3. Rise time may then be determined as the period between T_3 and T_2 and overall width as the period between T_3 and T_1. The predetermined rise time voltage at T_3 may be, for example, about 80% of V_o. Once this value is achieved, the timer 52 is stopped, the present sensor output voltage is stored, and switch 74 is opened, deenergizing waveform tracking circuit 72. If the waveform tracking information provided to the processing unit 50 over the control bus 60 comports with stored parameter ranges, then the waveform is deemed the result of a particular type of deliberate user motion and system logic proceeds accordingly. For example, a particular data set character designated by a pointer in an edit facility configured with a rotating selection method is selected.

Given the desirability of providing for recognition of more than a simple single motion hand wave, system logic is sufficiently sophisticated to recognize a variety of generic deliberate user motions. FIG. 9 is a schematic, graphical illustration of non-contact sensor output voltage as a function of time during a multiple step, exemplary actuation sequence in accordance with a preferred embodiment of the present invention. Here again, the sensor 24 is of the ambient light sensitive variety, a

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decrease in voltage corresponding to a decrease in ambient light sensed along a line-of-sight 32.

Once switch 22 is pressed, system 10 is switched from a first state into the data state in which switch 76 is closed and power is provided both to the sensor 24 and motion detection circuit 64. The first deliberate user motion depicted is an optional sensor touch in which the user covers the sensor 24 at Zone 0. The touch motion may be used to calibrate the system 10 by blocking substantially all ambient light along the line-of-sight of the sensor for a predetermined period. The period may be set based on the decay rate or fall time of the particular sensor 24 employed to ensure substantial decay of sensor output. Upon expiration of the predetermined time period and completion of calibration, system status may be indicated to a user by means of an audible beep, series of beeps or other indication. Upon uncovering the sensor 24, system 10 is ready for additional waveform analysis.

The first deliberate user motion depicted after touch calibration in FIG. 9 is a single motion hand wave similar to that depicted in FIG. 8. Note that since the period of the hand wave is substantially less than that of touch calibration, the minimum output voltage associated therewith is greater than that of touch calibration. This results in part due to the decay rate of the sensor 24 as well as the incomplete blockage of ambient light sensed by the sensor where a typical hand wave passes through Zone 1 or Zone 2 of the sensor 24.

The single motion hand wave is followed next by a three finger wave. Here again, due to the relatively short duration of successive interruptions of ambient light as each finger passes through Zone 1 or Zone 2 and the sensor line-of-sight 32, the minimum output voltages associated therewith are individually greater than those of both the hand wave and touch calibration motions.

Lastly, depicted is a hand clasp motion resulting in an extended duration blockage of ambient light along the

sensor line-of-sight 32. As stated hereinabove with respect to FIGS. 7A and 7C, a hand clasp at an appropriate point in the system logic for a predetermined time period may be used to delete a character or select a data file, execute an escape or altogether exit the data state. If the data state is exited, the sensor 24 and motion detection circuit 64 may be deenergized through automatic opening of switch 76 to minimize system power consumption.

FIGS. 10, 10A and 10B set forth a schematic, block diagram flow chart of sensor output waveform analysis in accordance with a preferred embodiment of the present invention. The flow chart replicates the steps discussed in detail with respect to waveform analysis of FIG. 8 and reference may be made thereto in combination with FIG. 8. It is notable that the flow chart methodology may be consistently applied to ascertain a variety of deliberate user motions, including those depicted in FIG. 9.

Referring once again to FIG. 6, waveform tracking circuit block 72 outputs a tracking information signal 80 based upon one of or both of the voltage and current of the detection circuit block 70. In a preferred embodiment, the tracking information signal 80 is input into the processing unit block 50, temporarily stored in RAM 58 and compared to predetermined waveform images stored in ROM 56. In this manner, spurious signals due to background effects may be rejected and differentiation may be made between different varieties of user motions. For example, differentiation may be made between a hand wave, a finger wave and other deliberate user motions depicted in FIG. 9 based upon minimum relative voltage, width, wave form shape, fall time, rise time, slopes or any of a variety of other ascertainable wave form characteristics and parameters.

In many instances, only minimal differentiation is required. For example, for the application of selecting a particular character from a data set by a non-rotating method, the desired result may be accomplished either by an "n" finger wave or "n" successive single hand waves. Only

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spurious signals due to background effects need be rejected. More exacting differentiation, however, may be desired in combination with more complex system logic as a means to facilitate skipping repetitive steps, for example. In any event, a particular system 10 may be configured with appropriately sophisticated waveform tracking capability and system logic to achieve a desired user interface 12 for a particular application, as desired.

FIG. 11 is a schematic, graphical illustration of system circuitry 82 in accordance with a preferred embodiment of the present invention. A filter 40 of passively variable light transmissibility characteristics is disposed between ambient light and sensor block 62, which includes a photovoltaic cell 84 and a voltage divider R1, R2. Before being input into the processing unit block 50, which might include a processor, micro-processor or other suitable electronic logic controller, signal 66 is conditioned by first passing through convertor 86, being converted into a form suitable for use by the processing unit 50. Depending on the requirements of the particular processing unit 50 selected, convertor 86 could be an analog-to-digital convertor, a voltage-to-frequency convertor or other suitable device. In the case of a system 10 where the sensor 24 is being primarily employed to determine gross changes in ambient light, such as those associated with a hand clasp motion, or to determine ambient day/night conditions, convertor 86 may simply be a single operational amplifier comparator, being used to compare the voltage of sensor output signal 66 to a predetermined reference voltage. Whatever the requirements of a particular application, once the sensor output signal 66 is conditioned by the convertor, the resultant output tracking information signal 80 may be input into the processing unit 50 for analysis and comparison, for example with predetermined waveform images as discussed hereinabove.

By providing the filter 40, bright outdoor sunlight which would otherwise tend to drive the photovoltaic cell to near saturation voltage, V_{cc}, is attenuated. By automatically reducing the transmissibility of light therethrough, the filter 40 acts in a substantially similar manner to an automatic gain control circuit 68. Associated sensitivity and automatic gain control circuitry 68 functionality of the wave form tracking circuitry 72 of the convertor 86 may thereby be simplified or eliminated altogether.

Detection circuit block 70 is employed to send the interrupt signal 61 to the processing unit 50 when the rate of change of decrease in sensor output signal 66 exceeds a predetermined rate, specified by selection of appropriate values for capacitor C3 and resistors R3 and R4. For example, when the voltage of sensor output signal 66 falls more quickly than the predetermined rate, C1 discharges causing the base of transistor T_X to turn transistor T_X on. In combination with the value of R3, a single pulse is delivered to the base of transistor T_Y. The pulse momentarily switches transistor T_Y, pulling interrupt signal 61 low. The processing unit 50 thereafter initiates analysis of the tracking information signal 80 to ascertain the occurrence and type of deliberate user motion indicated by any suitable change in waveform.

Processing unit 50 includes internal or external ROM 56 and RAM 58 and other conventional clock and counter functions as depicted in FIG. 6. System circuitry 82 also includes an LCD or other suitable display 20 connected to the processing unit 50. Switch 76 is employed to minimize overall system power requirements by selectively providing power to the convertor 86, detection circuit 70 and sensor block 62 only when required. Lastly, at least one manually actuated switch 22, SW1, is provided, primarily for switching the processor logic into the data state.

During operation, the system 10 and associated circuitry 82 are routinely in a low power state, for

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example a contemporaneous data display state displaying the current time. Manual actuation of switch 22 energizes the processing unit 50 and external circuitry 62, 70, 86 is concurrently energized through automatic closure of switch 76. In an exemplary embodiment, a main menu display of a plurality of menus, submenus, functions or other selections is presented on the display 20. The processing unit 50 awaits an interrupt signal 61 from the detection circuit 70 by any appropriate deliberate user motion in accordance with the rotating or non-rotating display method employed. A system logic generated interrupt may be used to automatically trigger the processing unit 50 after a predetermined timeout, if desired, either to proceed to the next display, escape the current display or exit the data state. Disabling the detection circuit 70 may also be accomplished at any time by a double actuation of manual switch 22.

In the event there exists insufficient ambient light to reliably actuate the system 10, processing unit 50 is preferably configured to open automatic switch 76, deenergizing external circuitry 62, 70, 86 and reserving system power. In order to provide continuing capability to retrieve, edit and input data when ambient conditions are otherwise unsuitable, an optional night light 142, source 42 or display back light may be energized. Further, a user could always have the option of operating the system 10 in the data state solely with the manually actuated switch 22.

FIG. 12 depicts a schematic, graphical illustration of a multiple step exemplary actuation sequence employing the switch 22 without utilizing any non-contact sensor capability. For purposes of explanation, the menus depicted herein are all of the rotating selection method, although as is readily apparent, any combination of rotating and non-rotating selection methods may be employed and all are considered within the scope of the present invention.

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Similar to system operation employing a non-contact sensor 24, upon entering the data state by manual actuation of switch 22, a main menu 20k is displayed. As depicted here, the user selects "MENU #3" when the rotating pointer is associated therewith by manual actuation of the switch 22. A series of submenus of "MENU #3" are thereafter displayed and "SUBMENU #3" is selected, again by the rotating selection method by actuation of the switch 22 when the rotating pointer is associated therewith. A series of data files of "SUBMENU #3" are thereafter displayed and "DATA #3" is selected, again by the rotating selection method by actuation of the switch 22 when the rotating pointer is associated therewith. Rotating selection method scroll speed and direction may be selected using repetitive switch actuation in place of non-contact sensor actuation as discussed hereinabove with respect to FIGS. 7C and 7D. Further, continued depression of the switch 22 for predetermined timeout periods may be employed to escape a present file or menu or exit the data state altogether in a manner similar to a hand clasp in combination with the non-contact sensor 24. An audible sound such as a beep, series of beeps or other indication may be provided at appropriate timeout periods to alert the user as to the status of the system 10.

While there have been described herein what are considered to be preferred embodiments of the present invention, other modifications of the invention will become apparent to those skilled in the art from the teaching herein. Further, any of a variety of data selection methods and variable contemporaneous data functions may be accessed in a data processing system 10 of the type disclosed. In addition to the specific day, date and time functions discussed, other useful functions may include elapsed time, ambient pressure, ambient temperature, altitude, depth, user pulse rate, user caloric intake, distance travelled, and one or more variable parameters of

a remote system in communication with system 10, or of sensors, monitored or controlled by system 10.

It is therefore desired to be secured in the appended claims all such modifications as fall within the true spirit and scope of the invention. Accordingly, what is desired to be secured by Letters Patent of the United States is the invention as defined and differentiated in the following claims.

CLAIMS

1. A user interface for a data processing system including power source, logic, processing unit, memory and display, said user interface comprising:

means for inputting data into, editing data in or retrieving data from said system in accordance with said logic, said data means comprising:

means for switching said system from a first state to a data state; and

at least one non-contact sensor actuated by motion of a user relative thereto, at least when said device is in said data state.

2. The invention according to claim 1 wherein:

said non-contact sensor includes an actuation zone along a line-of-sight thereof and an output signal which varies as a function of a variable parameter sensed along said sensor line-of-sight.

3. The invention according to claim 2 wherein:

sensor actuation is comprised of a predetermined change in said sensor output signal in accordance with said logic.

4. The invention according to claim 3 wherein:

said predetermined signal change occurs upon said user motion passing through said sensor actuation zone in a predetermined manner.

5. The invention according to claim 4 wherein:

said non-contact sensor comprises a light sensitive sensor and said variable parameter comprises light intensity.

6. The invention according to claim 5 further comprising:

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a filter or lens or both disposed, at least in part, across said sensor line-of-sight proximate said sensor.

7. The invention according to claim 5 further comprising:
a light source disposed proximate said light sensitive sensor.

8. The invention according to claim 4 wherein:
said non-contact sensor comprises a sonic sensitive sensor and said variable parameter comprises sonic vibrations.

9. The invention according to claim 8 wherein:
said sonic sensitive sensor comprises an ultrasonic detector in combination with an ultrasonic source disposed proximate thereto.

10. The invention according to claim 9 further comprising:
a protective element disposed, at least in part, across said sonic sensitive sensor line-of-sight proximate said ultrasonic detector.

11. The invention according to claim 8 further comprising:
a light source disposed proximate said sonic sensitive sensor.

12. The invention according to claim 2 wherein:
said sensor actuation zone comprises a substantially conical volume generally symmetrically disposed along said sensor line-of-sight.

13. The invention according to claim 12 further comprising:
a second non-contact sensor actuated by motion of a user relative thereto, said second non-contact sensor including an actuation zone along a line-of-sight thereof and an output signal which varies as a function of a

variable parameter sensed along said second sensor line-of-sight.

14. The invention according to claim 13 wherein:
respective actuation zones of said non-contact sensor and said second non-contact sensor overlap.

15. The invention according to claim 1 wherein:
said data state comprises:
a main menu display of one or more functions including at least one of one or more stored data display subfunctions for displaying stored data or one or more variable contemporaneous data display subfunctions for displaying contemporaneous data, wherein at least one of said one or more functions is selectable by actuation of said non-contact sensor.

16. The invention according to claim 15 wherein:
at least one of said one or more functions or subfunctions is selectable by actuation of said non-contact sensor and, at least in part, a rotating selection method.

17. The invention according to claim 16 wherein:
scroll speed or scroll direction of said at least in part rotating selection method is selectable by actuation of said non-contact sensor.

18. The invention according to claim 15 wherein:
at least one of said one or more functions or subfunctions is selected by actuation of said non-contact sensor and, at least in part, a non-rotating selection method.

19. The invention according to claim 15 wherein:
said stored data includes at least one of one or more help messages and user input data.

20. The invention according to claim 15 wherein:
said variable contemporaneous data includes at least one of one or more of time, day, date, elapsed time, ambient pressure, ambient temperature, altitude, depth, user pulse rate, user caloric intake, distance travelled, and one or more variable parameters of a remote system, or of sensors, monitored or controlled by said data processing system.

21. The invention according to claim 15 wherein:
at least one of said one or more stored data display subfunctions and said one or more variable contemporaneous data display subfunctions includes at least one edit facility to permit at least one of inputting, editing or retrieving respective data therein by a user.

22. The invention according to claim 21 wherein:
said edit facility data comprises at least one of alphabetic, numeric or other character data selectable by actuation of said non-contact sensor.

23. The invention according to claim 22 wherein:
said edit facility data is selected by actuation of said non-contact sensor and, at least in part, a rotating selection method.

24. The invention according to claim 23 wherein:
scroll speed or scroll direction of said at least in part rotating selection method is selectable by actuation of said non-contact sensor.

25. The invention according to claim 22 wherein:
said edit facility data is selected by actuation of said non-contact sensor and, at least in part, a non-rotating selection method.

26. The invention according to claim 1 wherein:

said switching means comprises a contact actuated switch.

27. The invention according to claim 1 wherein:
said switching means comprises a non-contact actuated switch.

28. The invention according to claim 27 wherein:
said non-contact actuated switch comprises said non-contact sensor.

29. The invention according to claim 1 wherein:
said non-contact sensor is disposed proximate said display.

30. The invention according to claim 1 wherein:
said user interface is disposed, at least partially, in a structure configured for donning by a user.

31. The invention according to claim 30 wherein:
said structure comprises a watch housing disposable about a wrist of a user, suspendable about a neck of a user or otherwise releaseably attachable to a user or to apparel of a user.

32. A data processing system comprising:
a power source for supplying power to said system;
logic for controlling data input into, data storage in and data display from said system;
means for storing said logic in said system;
means for inputting data into, editing data stored in or retrieving data stored in said system, said data means comprising:
means for switching said system from a first state to a data state; and

at least one non-contact sensor actuated by motion of a user relative thereto at least when said system is in said data state;

means for storing data input into said system or edited by a user; and

means for displaying at least one of data stored in said system or contemporaneous data according to said logic.

33. A method for processing data in a user interface of a data processing system including a power source, logic, processing unit, memory and display comprising the steps of:

providing a user interface having at least one non-contact sensor actuated by motion of a user relative thereto; and

inputting data into, editing data in or retrieving data from said system by providing predetermined motion proximate said sensor in response to information displayed on said display according to said logic.

34. A method for processing data in a user interface of a data processing system including a power source, logic, processing unit, memory and display comprising the steps of:

providing a user interface having one switch actuated by motion of a user; and

inputting data into, editing data in or retrieving data from said system by actuating said switch in response to information displayed on said display according to said logic.

4/28/2006, EAST Version: 2.0.3.0

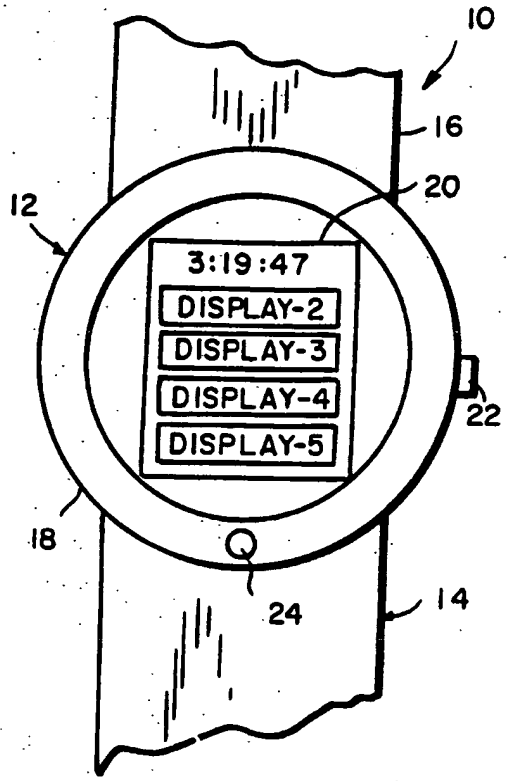

10
16
20
12
3:19:47
DISPLAY-2
DISPLAY-3
DISPLAY-4
DISPLAY-5
22
18
24
14

FIG. 1

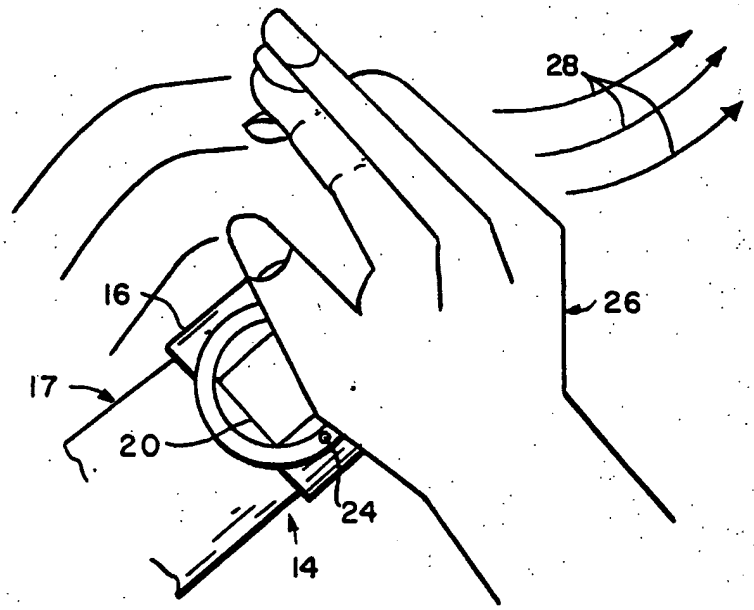

28
16
26
17
20
24
14

FIG. 1A

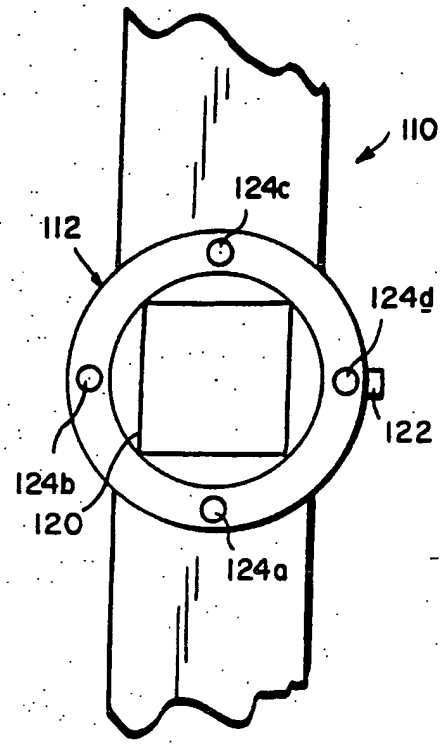


FIG. 1B

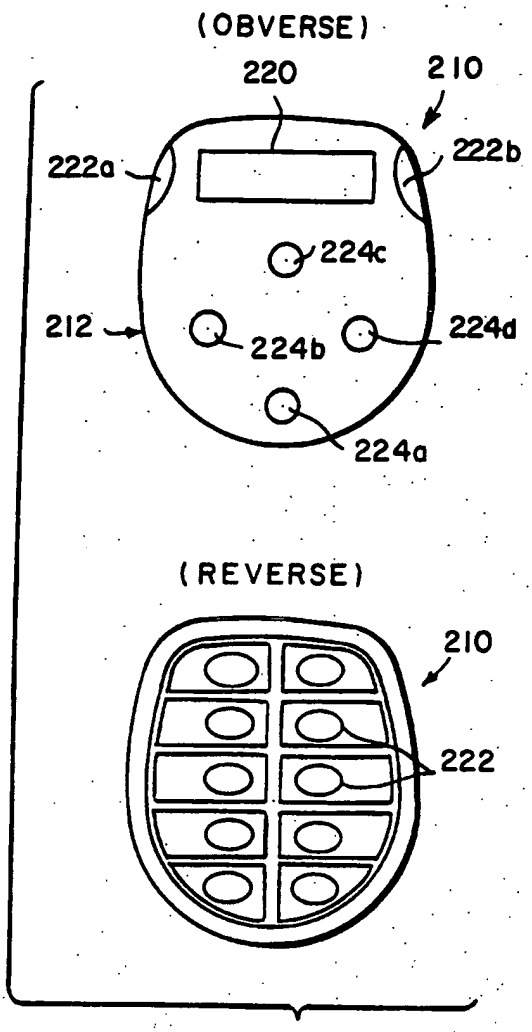


FIG. 1C

4/28/2006, EAST Version: 2.0.3.0

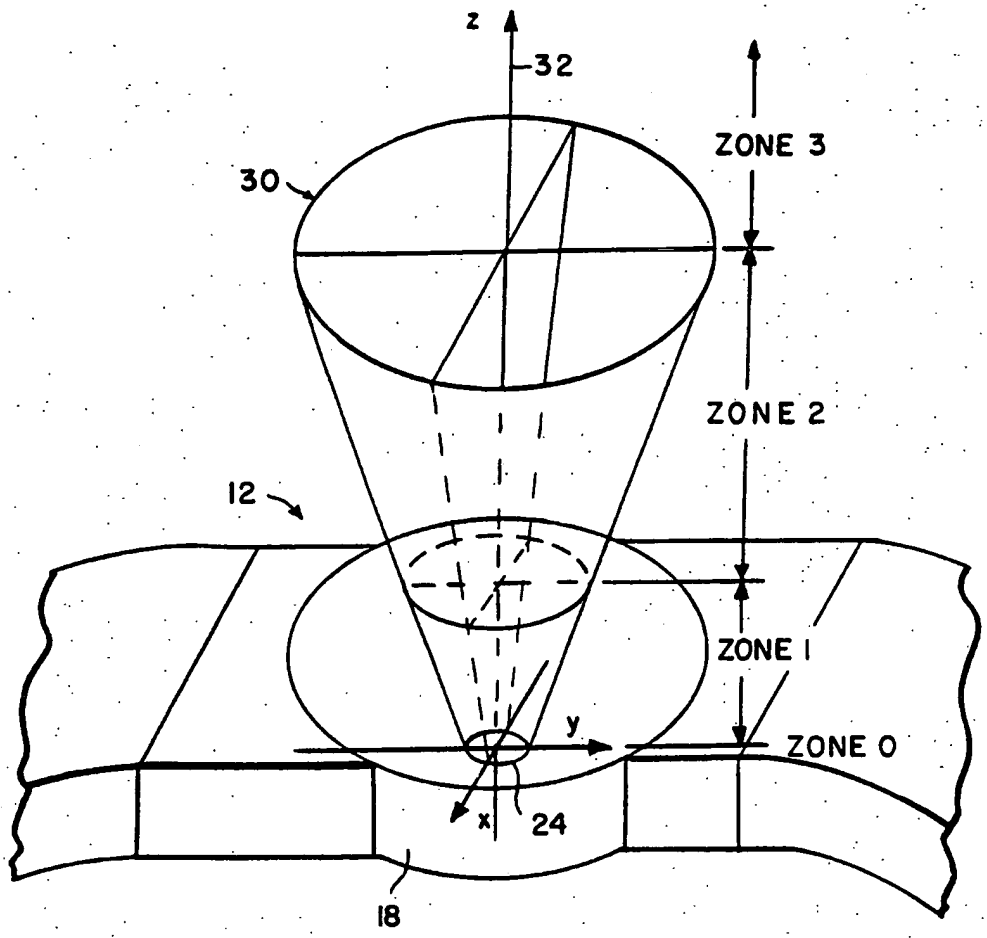


FIG. 2

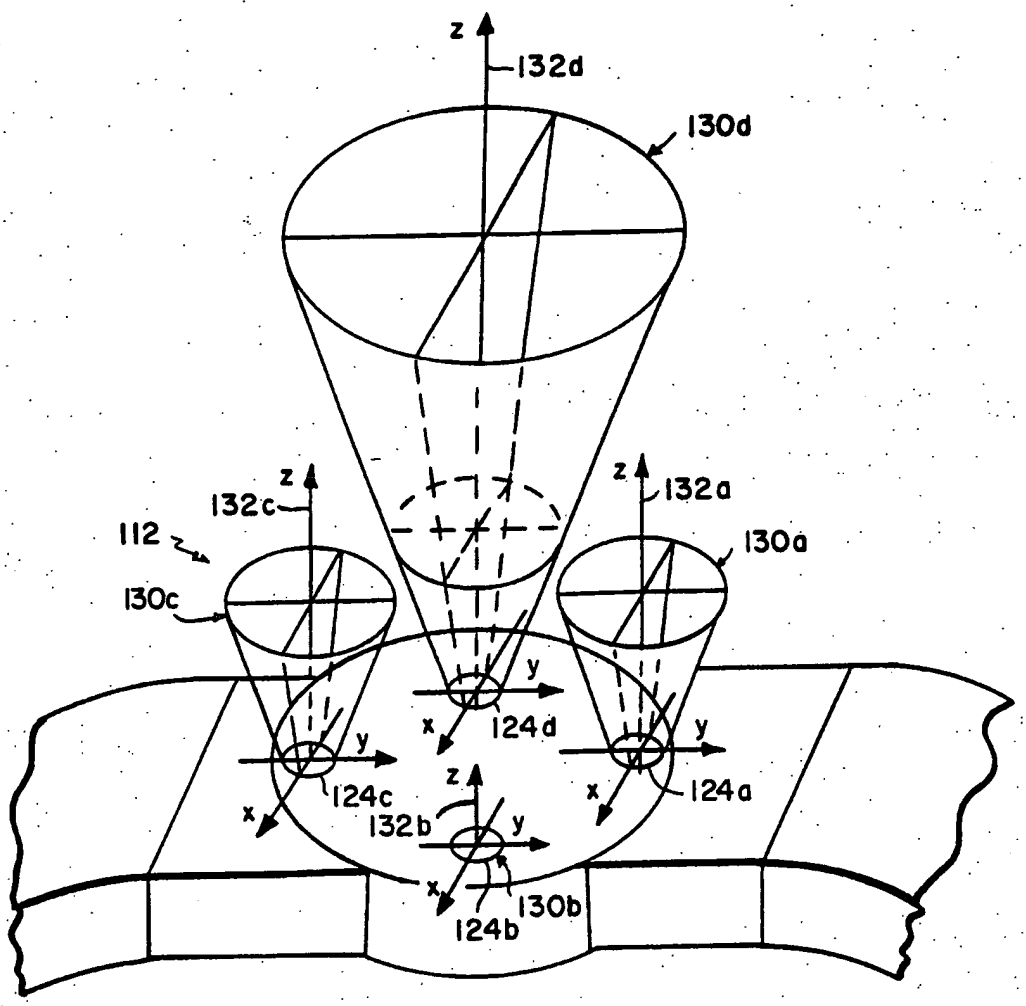

z
132d
130d
z
132c
112
130c
z
132a
130a
y
x
124d
y
124c
x
z
132b
y
x
130b
124b
y
124a
x

FIG. 3

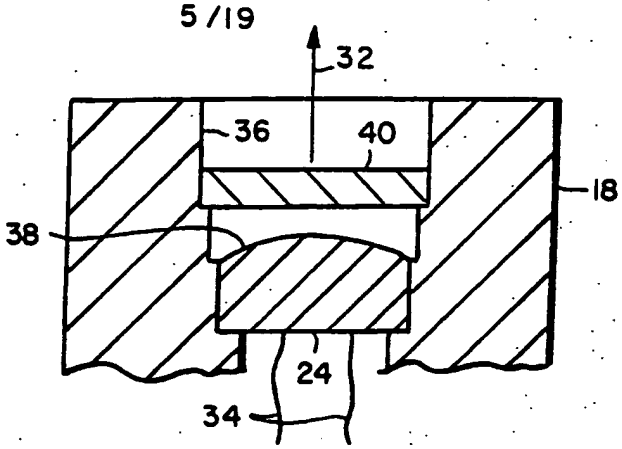


FIG. 4

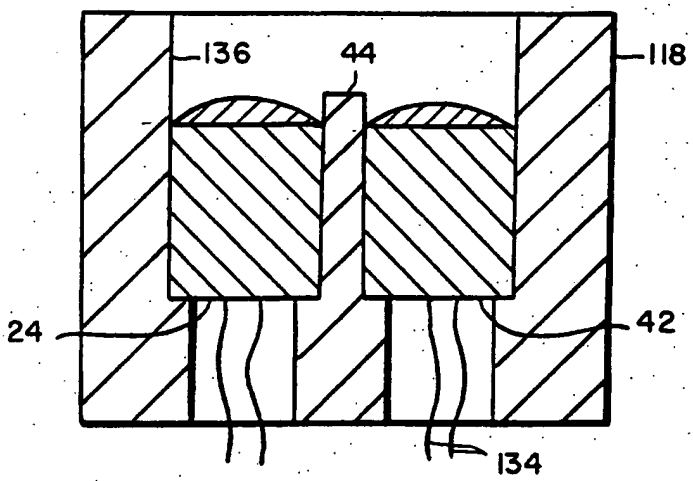


FIG. 5

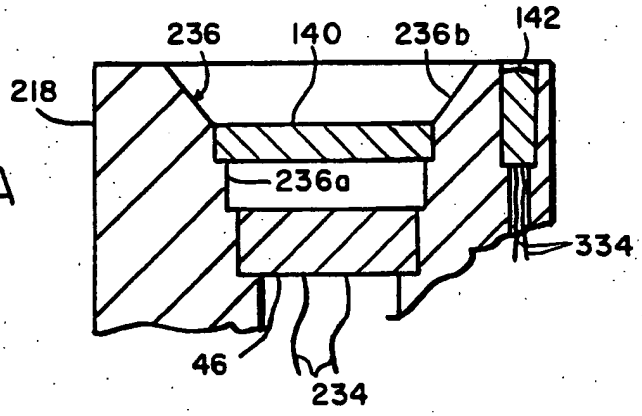


FIG. 5A

4/28/2006, EAST Version: 2.0.3.0

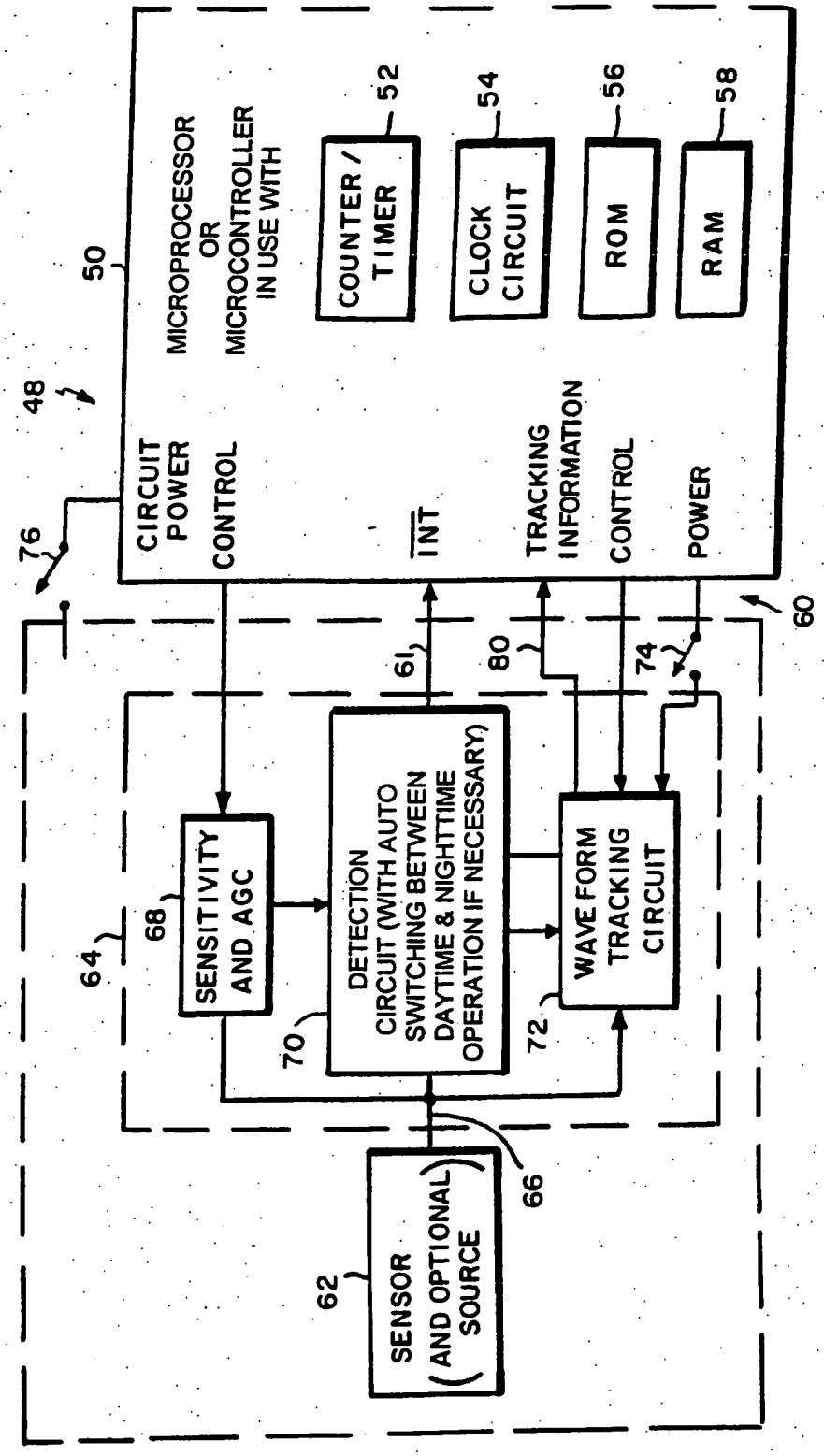

50
MICROPROCESSOR OR MICROCONTROLLER IN USE WITH
COUNTER / TIMER
52
CLOCK CIRCUIT
54
ROM
56
RAM
58
48
CIRCUIT POWER CONTROL
INT
TRACKING INFORMATION
CONTROL
POWER
76
60
61
80
74
64
68
SENSITIVITY AND AGC
DETECTION CIRCUIT (WITH AUTO SWITCHING BETWEEN DAYTIME & NIGHTTIME OPERATION IF NECESSARY)
70
WAVE FORM TRACKING CIRCUIT
72
66
62
SENSOR (AND OPTIONAL SOURCE)

FIG. 6

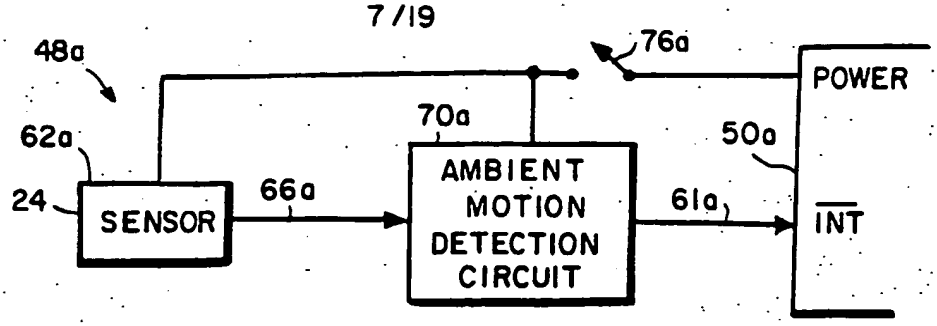


FIG. 6A

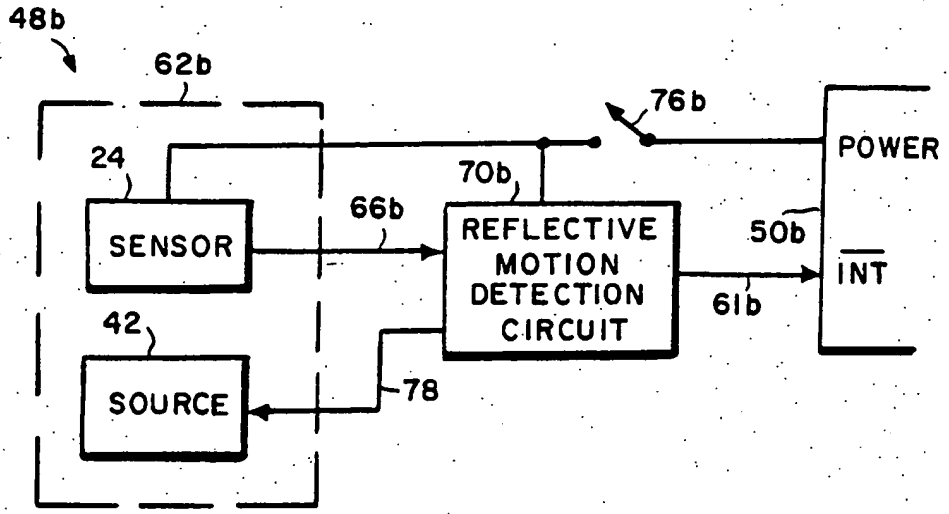


FIG. 6B

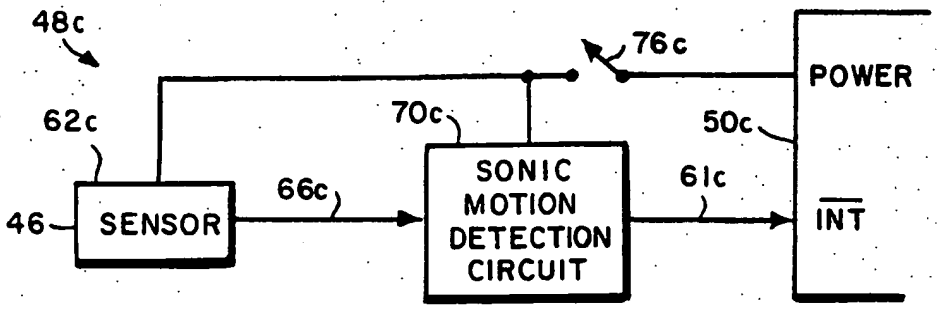


FIG. 6C

4/28/2006, EAST Version: 2.0.3.0

FIG.7

4/28/2006, EAST Version: 2.0.3.0

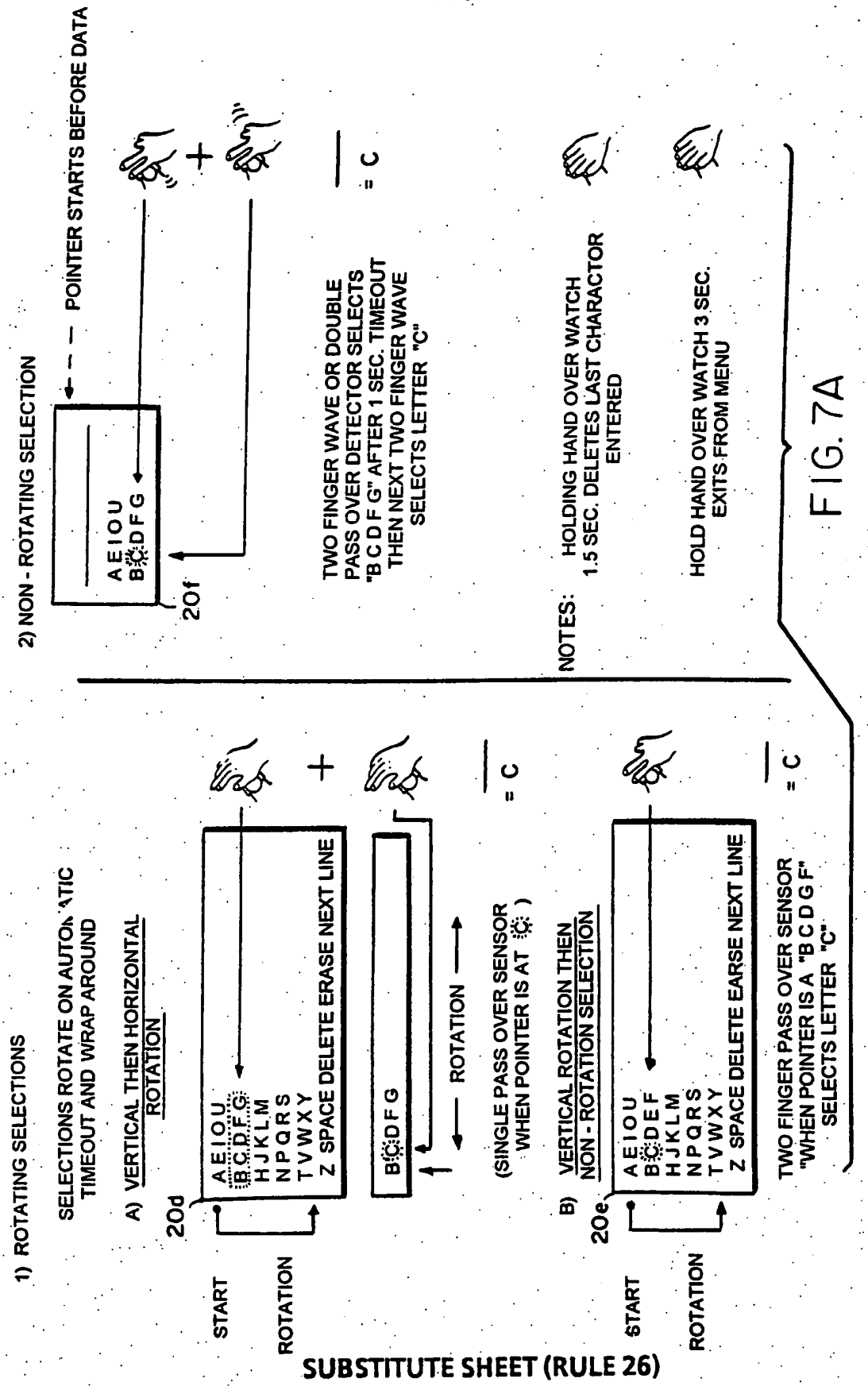


FIG. 7A

4/28/2006, EAST Version: 2.0.3.0

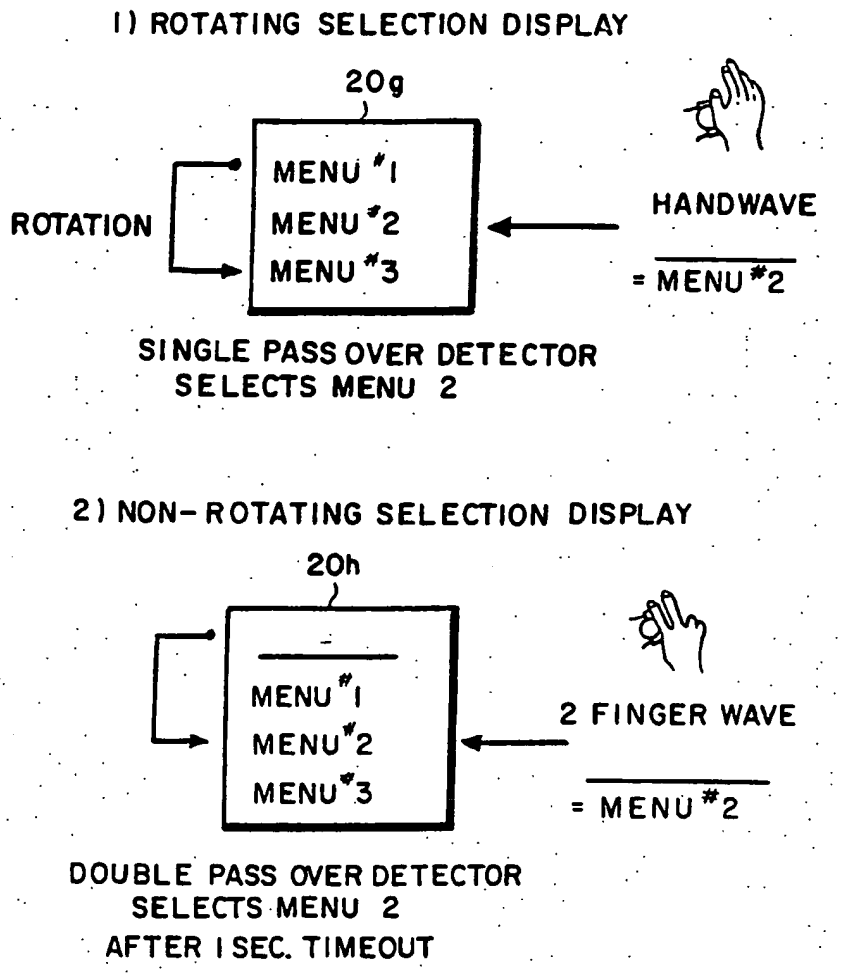


FIG. 7B

4/28/2006, EAST Version: 2.0.3.0

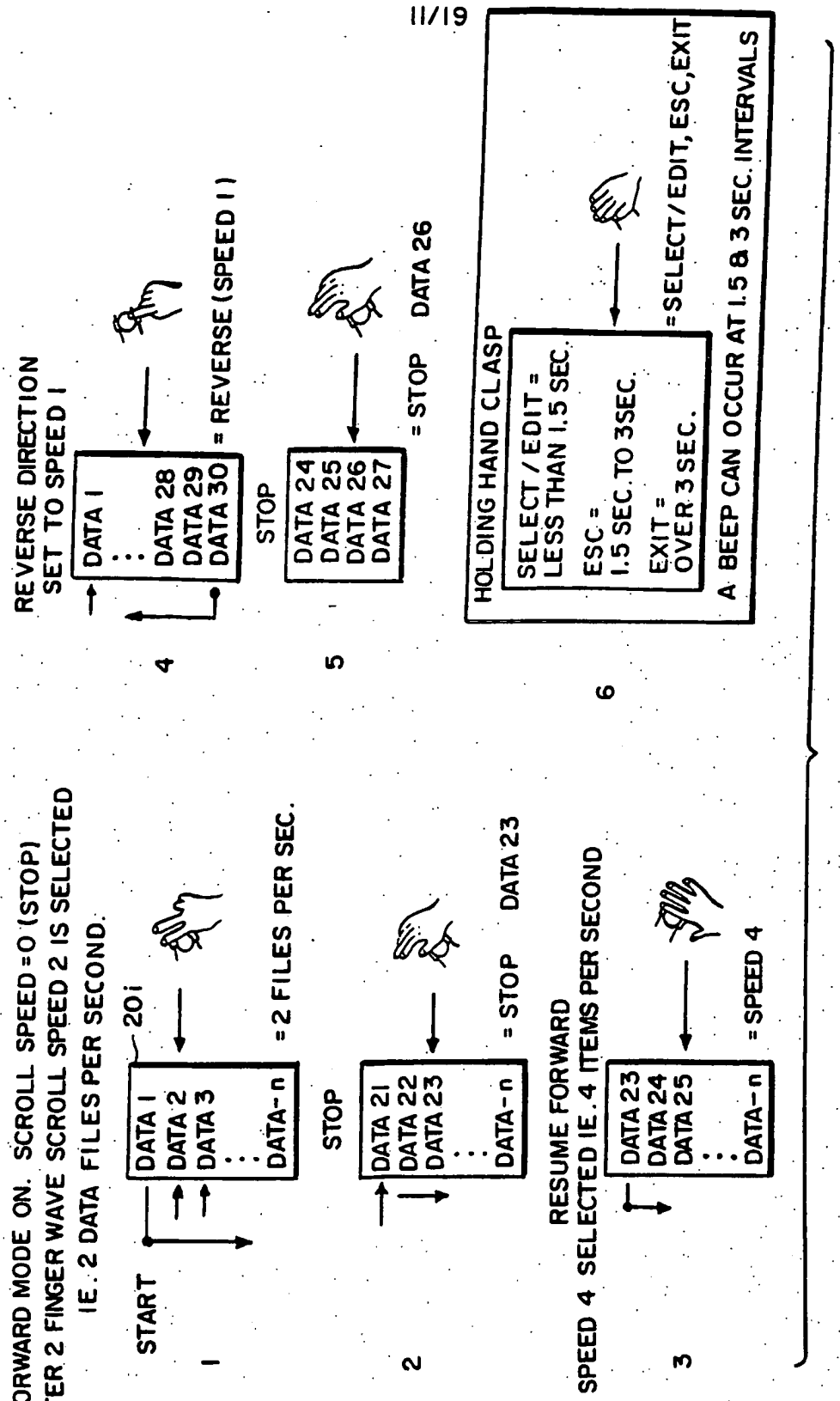


FIG. 7C

4/28/2006, EAST Version: 2.0.3.0

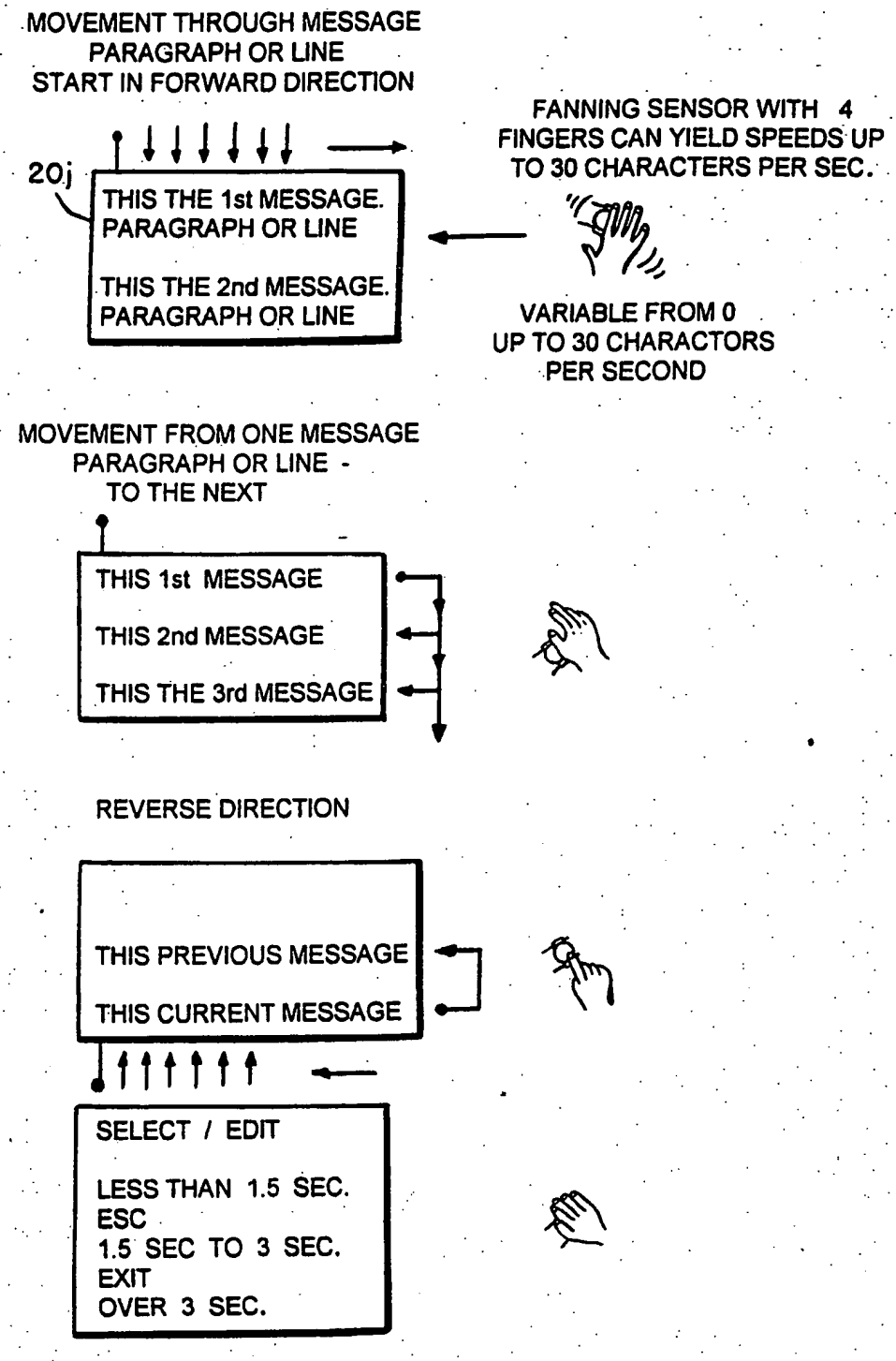

MOVEMENT THROUGH MESSAGE
PARAGRAPH OR LINE
START IN FORWARD DIRECTION
FANNING SENSOR WITH 4
FINGERS CAN YIELD SPEEDS UP
TO 30 CHARACTERS PER SEC.
20j
THIS THE 1st MESSAGE.
PARAGRAPH OR LINE
THIS THE 2nd MESSAGE.
PARAGRAPH OR LINE
VARIABLE FROM 0
UP TO 30 CHARACTORS
PER SECOND
MOVEMENT FROM ONE MESSAGE
PARAGRAPH OR LINE -
TO THE NEXT
THIS 1st MESSAGE
THIS 2nd MESSAGE
THIS THE 3rd MESSAGE
REVERSE DIRECTION
THIS PREVIOUS MESSAGE
THIS CURRENT MESSAGE
SELECT / EDIT
LESS THAN 1.5 SEC.
ESC
1.5 SEC TO 3 SEC.
EXIT
OVER 3 SEC.

FIG. 7D

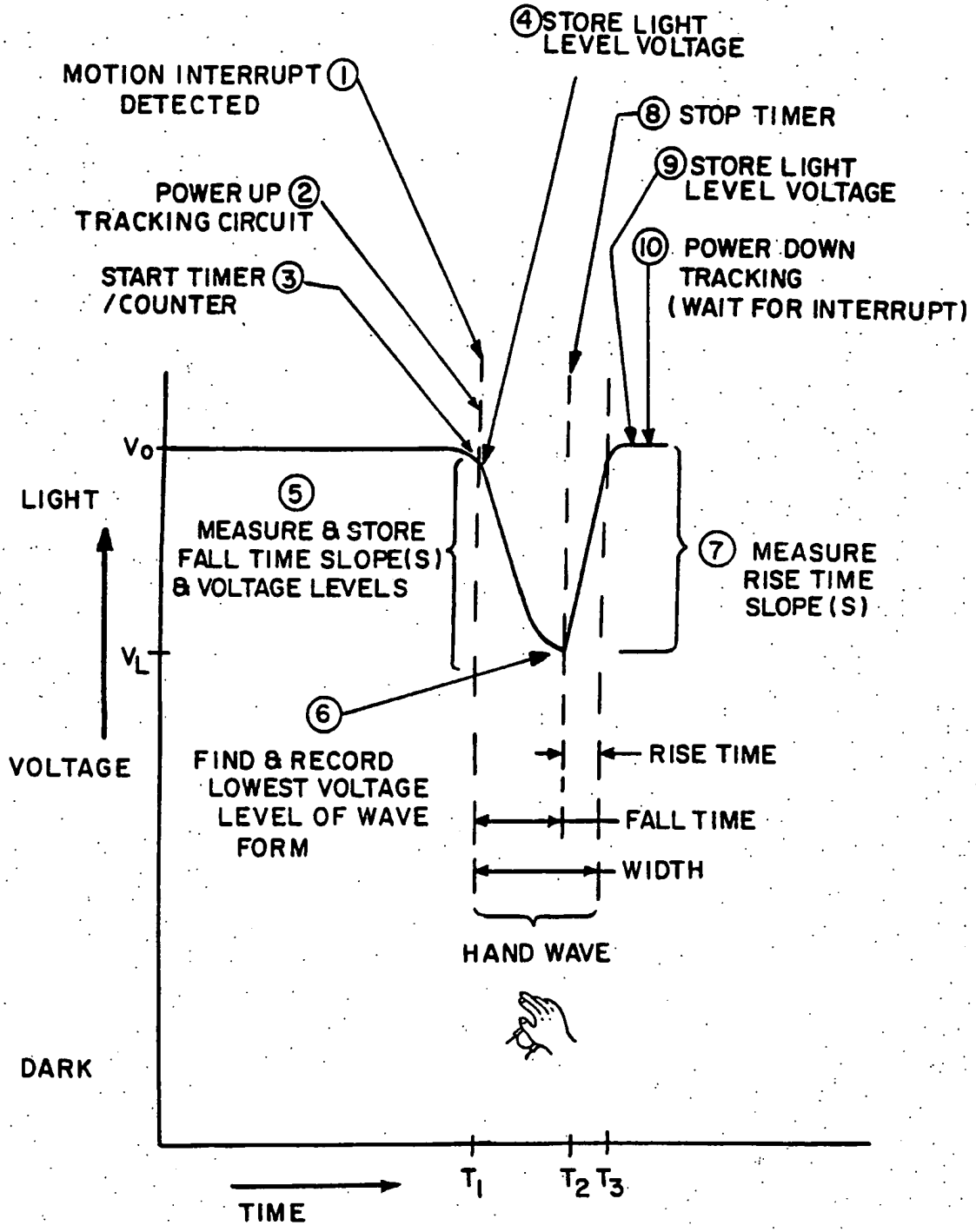


FIG. 8

4/28/2006, EAST Version: 2.0.3.0

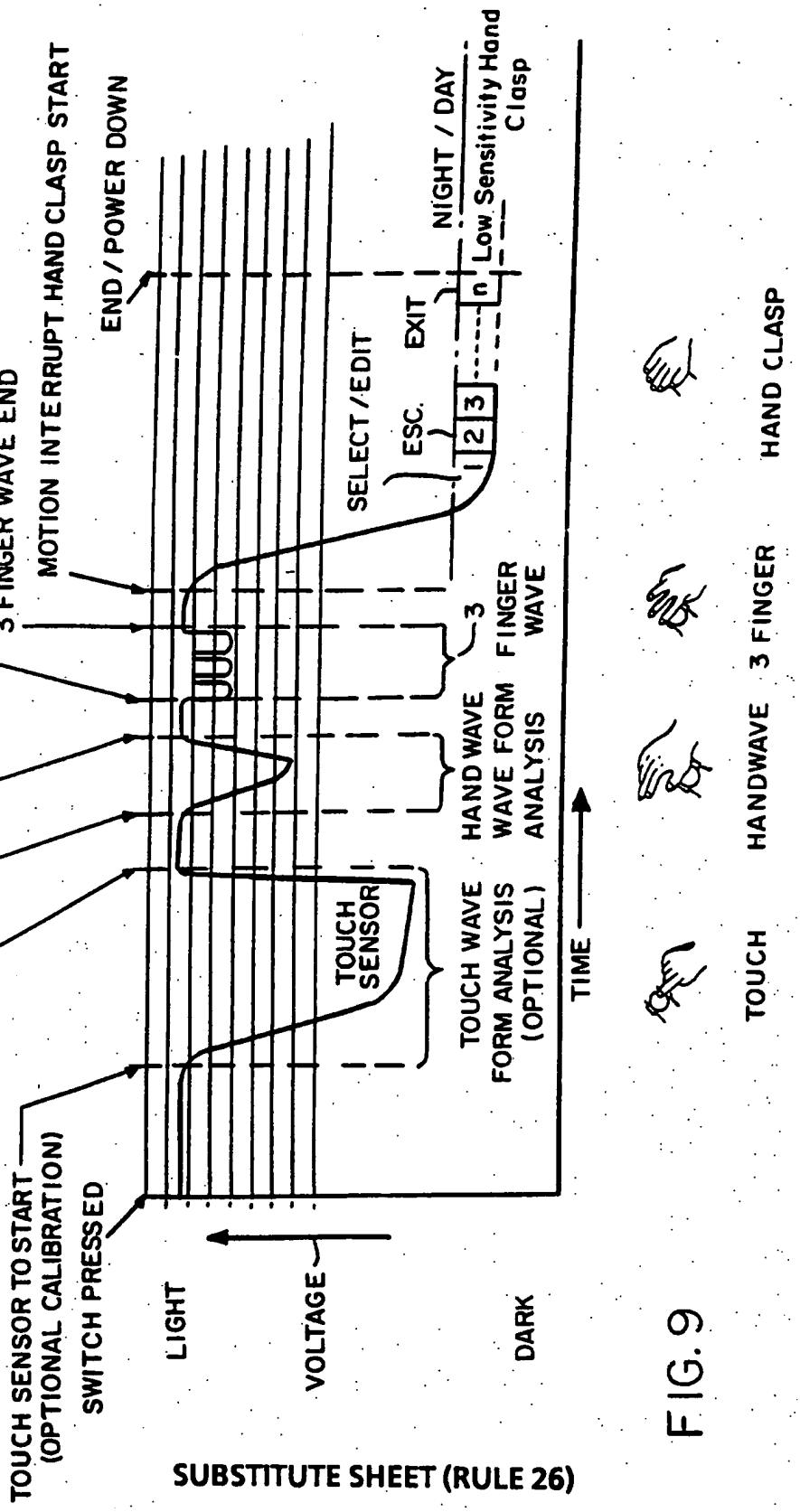
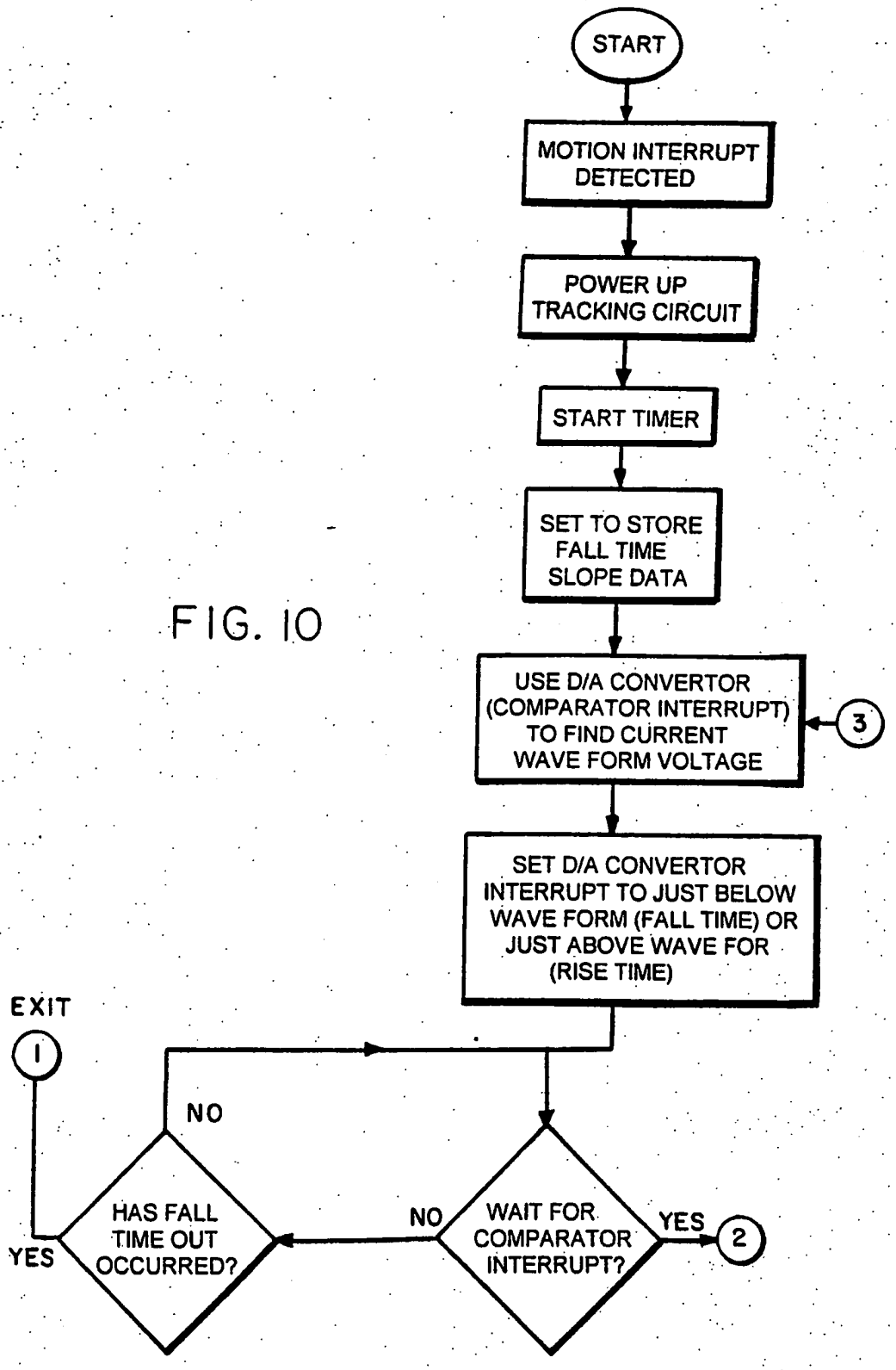


FIG. 9

4/28/2006, EAST Version: 2.0.3.0

FIG. 10



4/28/2006, EAST Version: 2.0.3.0

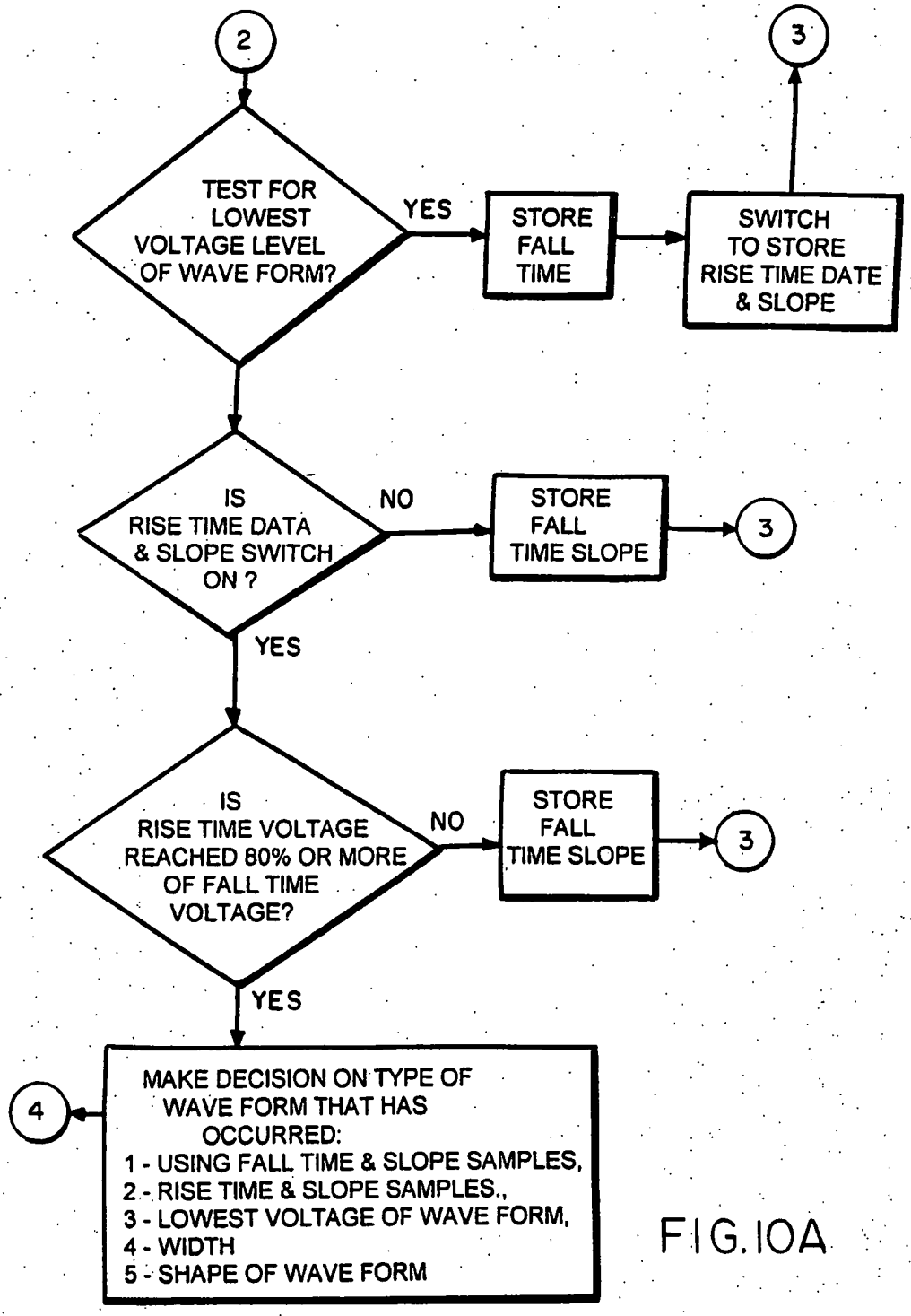


FIG.10A

4/28/2006, EAST Version: 2.0.3.0

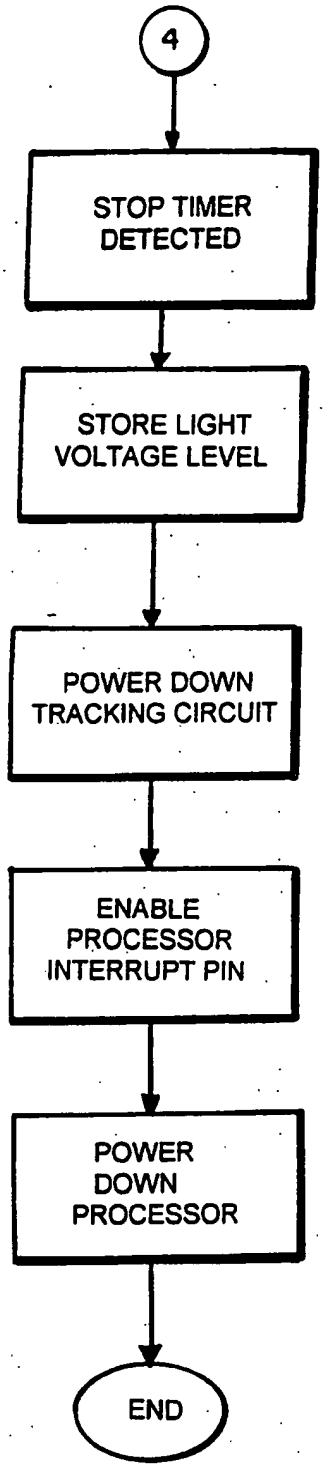

4
STOP TIMER DETECTED
STORE LIGHT VOLTAGE LEVEL
POWER DOWN TRACKING CIRCUIT
ENABLE PROCESSOR INTERRUPT PIN
POWER DOWN PROCESSOR
END

FIG. 10B

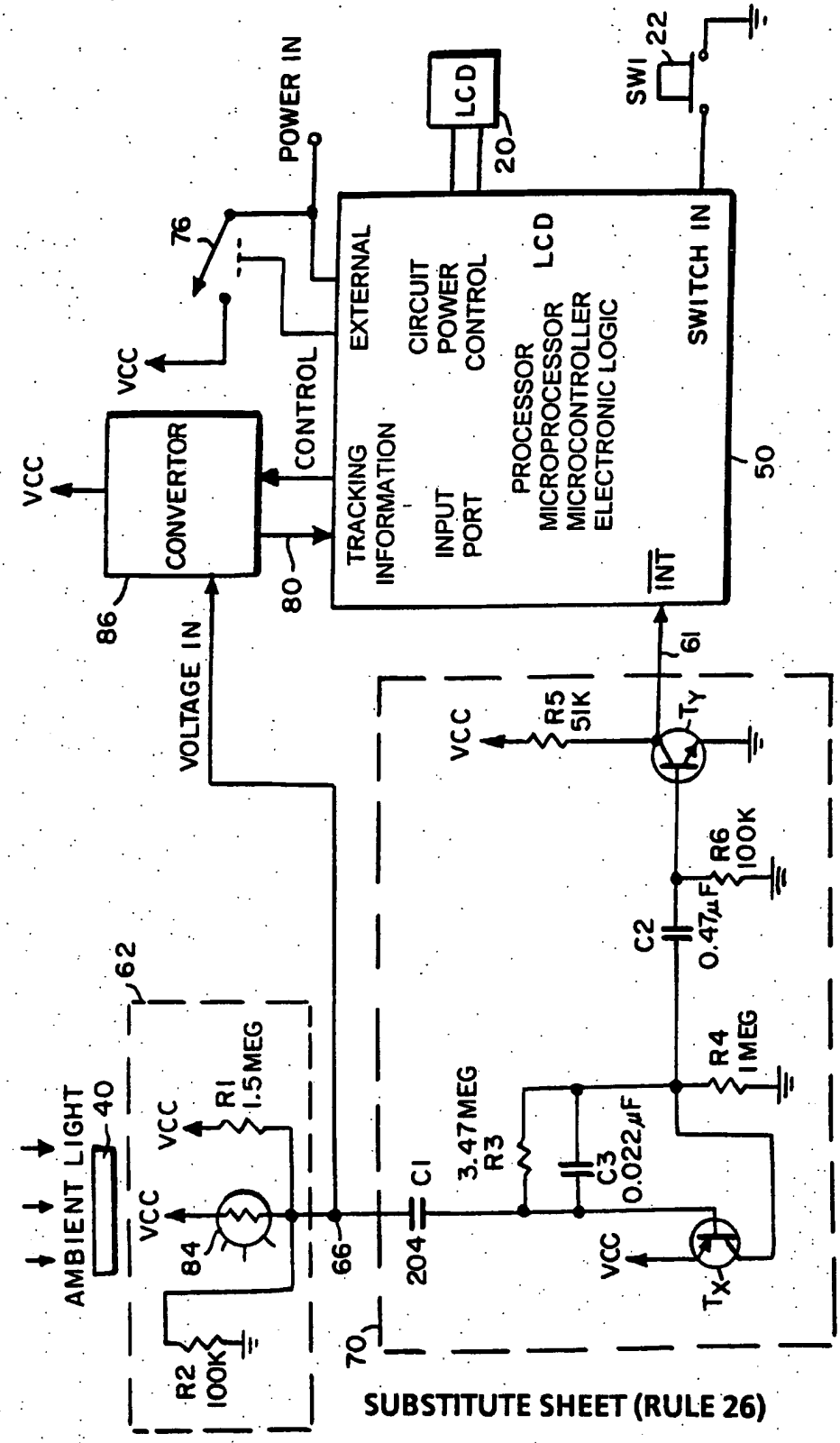


FIG. 11

4/28/2006, EAST Version: 2.0.3.0

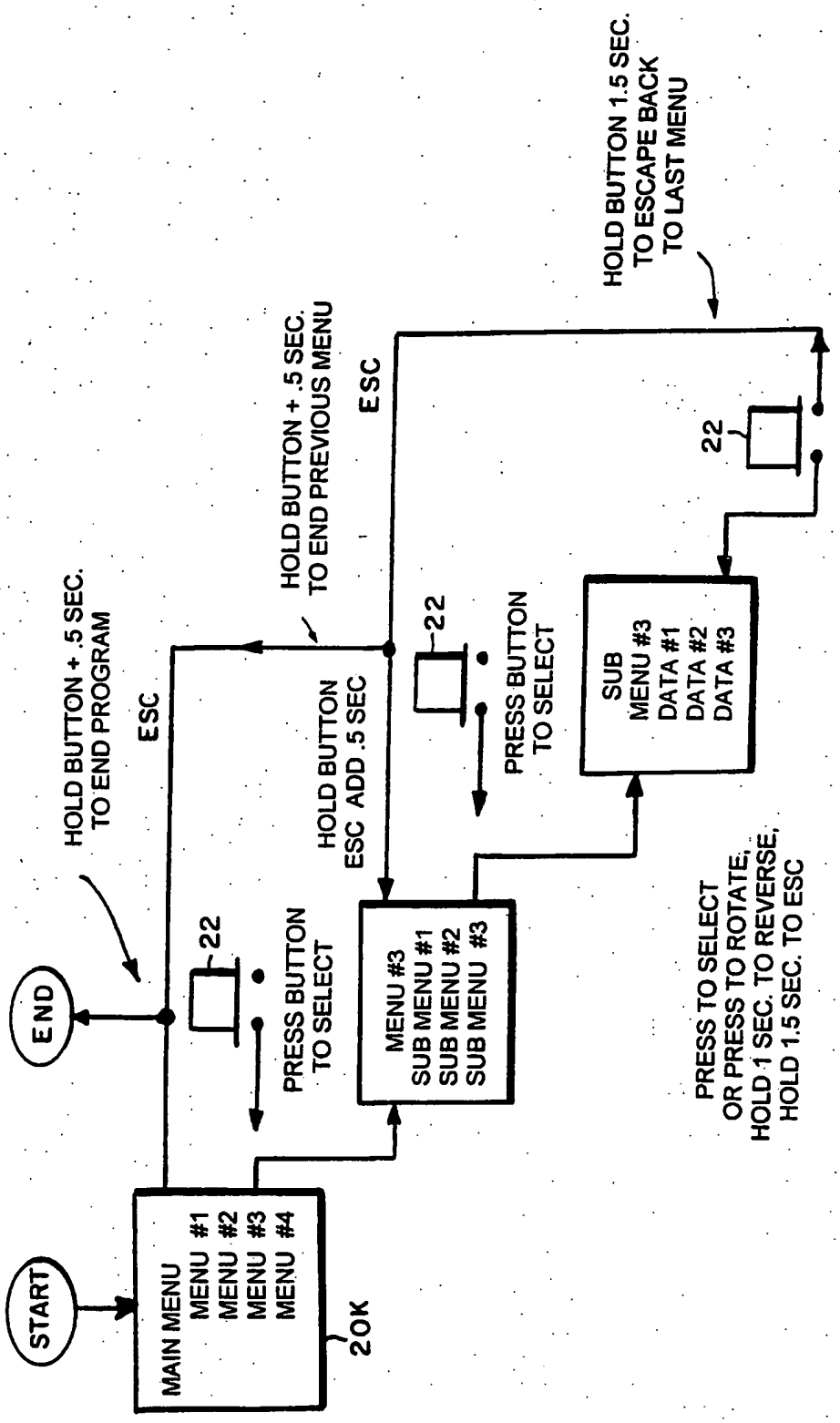


FIG. 12

4/28/2006, EAST Version: 2.0.3.0

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/07255

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G09G 5/08; G04C 23/10
US CL :345/158,175; 364/705.07; 368/70
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4,070,649 (WRIGHT, JR. ET AL.) 24 January 1978, col. 5, lines 54-60; col. 7, line 57 to col. 8, line 6; col. 14, lines 12-32 and figures 10 and 11.	1,26-34
X	US, A, 5,325,133 (ADACHI) 28 June 1994, col. 3, lines 35-47; col. 5, lines 42-65; col. 6, lines 44-45 and figures 1 and 2.	1,2,12-13,32-34
Y	US, A, 4,369,440 (PIGUET ET AL.) 18 January 1983, col. 2, lines 49-52; col. 4, lines 3-14; col. 4, line 45 to col. 5, line 5; col. 8, lines 4-25 and figures 1 and 2.	1-5,8-9,27-34
Y	US, A, 4,764,910 (ICHIKAWA) 16 August 1988, col. 6, lines 25-36; col. 8, lines 40-57; col 10, lines 5-44 and figures 7, 11, 12, 17 and 19.	1-5,8-9,27-34

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be part of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 SEPTEMBER 1996	04 OCT 1996
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer STEVEN J. SARAS Telephone No. (703) 305-4718

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/07255

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,894,813 (PÄCHER ET AL.) 16 January 1990, col. 2, lines 17-42.	8-9
Y,P	US, A, 5,477,508 (WILL) 19 December 1995, see entire document.	15-26

Form PCT/ISA/210 (continuation of second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/07255

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

84/600; 235/439,454,472; 345/156,157,158,173,174,175,179; 364/705.07; 368/42,43,44,69,70,84,189,250,255,256; 382/186,187,189,190,191,320,321,325